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ABSTRACT

This document presents 194 papers discussing technology and teacher education in the following areas: diversity and international perspectives; research in information technology for teacher education (ITTE); concepts and procedures; preservice teacher education; integration of technology into methods courses; inservice and graduate education; computer-based simulations in educational research and application; technology projects; theory and practice in ITTE; the educational computing course; hypermedia and multimedia; mathematics; science and social studies; reading and language arts; preservice use of telecommunications; inservice, graduate, and faculty use of telecommunications; and technology diffusion in teacher education programs and elementary and secondary schools. The articles are divided into sections according to topic; and an introduction to, and summary of the articles is provided at the beginning of each section. (Author/AEF)

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DIVERSITY AND INTERNATIONAL

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Diversity and International Perspectives

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The papers in this section clearly reflect that, as a field, we have moved beyond discussions of how to teach about information technology to how to incorporate information technology into the preparation of teachers. More importantly, these authors are critically reflective not only about what that means but also about the implications it has for our responsibilities as teacher educators. These authors do not present technology as a panacea that will "cure" what ails teacher education but, rather, as a reality that we and the teachers we prepare will encounter with increasing frequency. Teachers, as well as other citizens of the world, must be enabled to use technology in their daily lives if they are to become full participants in an increasingly interconnected global environment. But, because they are teachers as well, they must also be prepared to use technology in their professional lives in ways that assure the full development of all of their students.

This is the important focus of the papers by these authors. They each present an important issue for us to consider as we reflect on how well our own uses of information technology foster the development of our students as professionals. Are we using technology to provide an equitable and quality education for all students or do we integrate it in ways that continue current inequities or create new ones? How thoughtfully have we planned for the incorporation of information technology into our teacher education programs and into the schools that the teachers we prepare will work in? Are we appropriately critical of the software we use — does it reflect our needs rather than the developers' needs? Are there lessons teacher educators can learn from other countries and how they have integrated technology into education? What factors may play a role in determining if and how teachers use technology in the classroom? How can teachers establish an environment in their classroom that encourages all students to have positive experiences with technology? Are there other goals of teacher education that should be considered when educating pre-service or in-service teachers about information technology? These are some of the critical questions that come to mind when looking to the future of the role of technology in teacher education. The authors in this section provide insight into these and other questions related to the important topic of diversity and technology.

The paper by Assheton-Smith highlights the importance of integrating the provision of equipment, the preparation of both in-service and pre-service teachers, and the development of appropriate software. His discussion of the Computers in the Schools and Colleges Project currently underway in the Cape Province in South Africa clearly shows how each element is a necessary but not sufficient condition for preparing teachers who are computer-literate. All elements, provided in a coherent and integrated fashion, are essential. An exciting aspect of the Computers in the Schools and Colleges Project is the incorporation of a research and development component to not only assess the overall project but to develop software-based teaching materials relevant to local curricula — to eliminate and/or address the possible cultural and technical bias of software developed overseas. This is not an issue that has been addressed by many of us in the past.

Drawing from their experience teaching in a Diploma program in Educational Computing at the University of Port Elizabeth in South Africa, Bean and Cowley provide a broad consideration of the state of technology preparation for teachers in South Africa today. They emphasize not only the limited degree of preparation in the educational use of computers that all teachers have had but also point out discrepancies in that training. This is particularly distressing given the ethnic composition of teachers in South Africa. Although the majority of teachers are Black, they have had the most limited preparation in the educational uses of computers. Bean and Cowley's discussion of their own program, however, points out how education can serve as not only an environment for providing skills and knowledge but as a context for social change. They shift our consideration of technology preparation to a more complex level. They encourage us to think beyond teaching students about technology or incorporating technology into our programs to thinking about how the accomplishment of both of those goals can foster the development of more important goals such as inter-group cooperation.

Patrick Bean suggests that technology can be used to overcome current educational crises. Although he focuses specifically on the crisis in South Africa, his suggestions have wide applicability. He discusses factors influencing the successful implementation of technology. These factors have implications for the successful implementation of any educational change. They include political influence exerted in a supportive way; a strong economy to fund change; coherent and integrated planning; private sector support; the involvement of teacher education; computer literacy at all levels of the community; building on existing projects, initiatives, and skills; and employing information technology as a facilitator. As he further notes in relation to information technology, "any country, community, or organization not maximizing the use of information technology will suffer from an ever-widening deficit in contrast with countries utilising it in a directed manner." This makes our responsibility for preparing teachers to be thoughtful users of technology even more significant.

Knezek and his colleagues' paper informs us that South Africa is certainly not alone in trying to discover how best to educate teachers about technology. They compare the approaches of China, Japan, Thailand, and the United States of America (USA). There are some striking similarities across these four countries which suggest that many patterns in teacher education and technology are widespread. For example, although teachers are growing more enthusiastic about the use of technology in the classroom, they continue to receive inadequate training. The authors suggest that given the similarities across these countries, problems encountered in the USA may foreshadow future problems in other countries. An unfortunate trend in the USA is that the majority of teachers who have resources and adequate training do not use technology in their classrooms. This trend suggests that resources and training are necessary, but not sufficient components of a plan to include the use technology in the curriculum. Teacher educators must take seriously the responsibility they have for preparing teachers who will actually use available technology. Knezek et al. point out that an important first step toward this goal is that teacher educators must educate themselves about technology.

Yuen-kuang Cliff Liao and Su Chin Shih suggest that there may be more to using computers in the classroom than training and resources. They argue that more needs to be known about individuals' attitudes towards computers. Not surprisingly, past research has indicated a positive relationship between computer attitudes and computer literacy. In their study, they examined the computer attitudes of undergraduate students. The results indicated that gender may be an important factor to consider when training pre-service or in-service teachers to use technology. In general all students had positive computer attitudes, but the male students in their study had more positive attitudes than the female students. In addition, they found that there were different patterns of attitude change for males and females as they gained more experience. Males tended to be more confident and like computers more in a relatively short period of time (0-3 months). For females, however, there was an increase in positive computer attitudes after 6 months of computer experience. This result may have important implications for the computer education of teachers. Female teachers may require frequent and relatively long term computer training in order to produce the positive computer attitudes that will lead them to incorporate available technology into their curriculum.

The relationship between gender and technology is also one that Hutchinson and Kung explore in their paper. They point out that although the National Council of Teachers of Mathematics (NCTM) has advocated the need for all citizens to be mathematically literate, females are much less likely than males to choose careers related to math (e.g., engineering). Research has shown that there are many reasons for this gender gap, such as lack of female role models and teacher attitudes about girls and math. Hutchinson and Kung describe their project which was aimed at increasing the number of girls interested in math related careers. They propose that not only do teachers need to be aware of the gender issues related to math education, they also must be familiar with ways that computer technology and manipulatives can be used successfully with female students. Teachers who participated in the program have gone back to their schools and taken on the responsibility of educating their fellow teachers about these issues. This kind of dissemination of information is crucial if advances are to be made in reducing the gender gap. Teacher education must not only encourage teachers to be sensitive to different needs as students learn about technology but must also help them devise ways of approaching curriculum differently, given these different needs.

Robertson argues in his paper that there are ways to educate prospective teachers about technology and issues related to diversity at the same time. Technology can be

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used as a means of increasing pre-service teachers' sensitivity to and understanding of cultural diversity. He describes an approach to teaching the use of technology in the classroom through the use of a data base of Black and Hispanic owned businesses. As students learned various techniques, such as sorting, they also were educated about a segment of business owners of which there is little public awareness. It is through methods such as these that pre-service teachers' stereotypical beliefs about cultural groups are challenged in a non-threatening, non-confrontational manner. There is little disagreement that teacher education must prepare teachers to use technology in the classroom, but this goal need not be accomplished without attention to other important goals, such as promoting cultural awareness and understanding.

These papers clearly convey the permanent place that technology has in education and, therefore, must have in teacher education as well. One question that naturally follows is what is the role of the individual teacher educator? In some respects this will differ depending on the particular circumstances of the region or country the teacher educator teaches in. However, largely *because* of technology, our world is becoming one community and therefore, many of our technological needs are similar. A consistent theme in these papers is that diversity issues are extremely important considerations when looking to the future of technology. Whether we are referring to Blacks in South Africa, citizens in developed countries, women, or minorities in the USA, all groups must have access to technology. Teacher educators throughout the world must take responsibility for making certain they and the pre-service and in-service teachers they work with are adequately educated about the issues discussed in these papers if there is to be significant progress in the quality of technology education students receive and, in turn, how well we are all able to positively contribute to an increasingly, interconnected global environment.

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Getting Computers into the Classroom — a South African Perspective

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Education during the apartheid years in South Africa was based on ethnic, tribal, and language groupings. The underlying philosophy behind this segregation was the concept of mother-tongue instruction for the initial years of education. As a result, school education in South Africa is currently controlled by 17 education departments, of which four provide for white pupils, one each for Coloured pupils (people of mixed race) and Indian pupils and the remainder for Black pupils, including the homelands and the self-governing states (Clark, Hosticka & de Neuilly Rice, 1993).

During the 1980s several attempts were made to introduce computers into classrooms. These initial projects achieved only limited success for a variety of reasons, not least due to the emphasis on the provision of equipment rather than on training teachers to use the equipment. There have been similar experiences in other countries around the world (Hawkridge, Jaworski and McMahon, 1990).

The Computers in Schools and Colleges Project

In the second half of 1991, after an 18 month planning phase, the Department of Education and Culture: House of Assembly and the four provincial education departments associated with it jointly launched a project for computer-based education in schools and colleges. Each department has proceeded along its own path within the guidelines laid down for them. The discussion that follows outlines the process, identified as the Computers in Schools and Colleges Project (CISC), developed by the Cape Education Department.

As indicated above, earlier individual attempts by schools to introduce information technology were largely aimed at providing hardware and software for classroom use. Just as Davis (1992) found in the United Kingdom, these initial attempts failed to include teacher education institutions. Training of teachers was mostly carried out internally by schools on an ad-hoc basis, allowing many teachers not interested in the new technology to opt out of the process. The CISC project aims to avoid these shortfalls by only providing equipment to schools where teachers have fulfilled minimum training requirements, either pre-service or in-service. The project is also intended to address another problem area. Schools and teachers have been unable to integrate information technology into most subjects. Initial investigations indicated that subject syllabi provides only the most scant details of any integration and little if any software was available which covered content included in local curricula. This was particularly evident in secondary schools. Cultural and technical bias (Harrington, 1993) in software developed overseas was often overlooked. To address these issues the project, broadly speaking, is based on three parallel processes:

1. The provision of computer equipment and software to schools on a phased basis and the provision of in-service computer-literacy training for teachers.
2. The provision of equipment and software to teacher training colleges for the training of pre-service teachers.

3. The establishment of project schools for the testing and development of software-based teaching material for local curricula.

As a result of sanctions, South Africa is essentially a single platform environment, based on the PC clone market. It was, therefore, easy to standardise training based on the configuration of the equipment to be provided to schools. Budget constraints and the need to provide large amounts of equipment resulted in participating schools receiving batches of equipment consisting of two computers, a printer with a sharer, and copies of an integrated software package on an annual basis until a maximum ratio of one computer per 50 pupils is reached.

Software selection is an ongoing process. As the initial thrust of the project is aimed at teacher training in basic computer literacy, it was decided to supply an integrated software package with all equipment. Microsoft Works was chosen for this purpose. In order to qualify for each batch of equipment, participating schools are required to send at least two teachers to the local Teachers' Centre for a week long in-service training course on Microsoft Works.

A cascade approach to training is employed. This approach requires that the individuals who receive initial training from specialists at their local Teachers' Centre assume responsibility for training their colleagues at school. As Hawkridge and McMahon (1992) point out, the success of a cascade training system depends heavily on the trainers at each level of the cascade. They must be provided with a robust support structure and an effective communications system to assist them in the process.

To this end the Teachers' Centres in the Cape Province provide a node for supporting teachers through in-service training, technical assistance, and subject-related support. As the project progresses, careful monitoring of the skills of teachers at all levels of the cascade will need to be made in this area. A process of feedback from the lower levels of the cascade will need to be implemented in order to expand the network of trained, technologically capable teachers within the system. This is where the real return on the investment in equipment will be realised.

The training itself has evolved during the project and emphasises:

1. A hands-on approach to the four basic applications in MS-Works using curriculum-based examples. Teachers are encouraged to experiment for themselves.
2. The relationship between information technology and the curriculum.
3. The teacher as the learner — concepts that they find difficult to grasp may also be difficult for them to teach to other teachers in the training cascade or to teach to pupils.
4. Didactic strategies for the implementation of the new technology in the classroom.

The first two years of this phase of the project are, thus, aimed at the provision of small amounts of equipment for the teaching of basic computer literacy skills to all teachers in the participating schools. At the same time all pre-service teachers at teacher training colleges are required to take a computer literacy course based on the same integrated software and training approach.

Concurrently, several Project Schools have been identified. These schools, in contrast to other schools, have been provided with fully equipped computer laboratories and the staff given intensive in-service training. The task of the project schools is to (a) test curriculum-based software developed/purchased for the project; (b) develop in-house, end-user type packages that can be used in conjunction with MS-Works or similar integrated software. Once these computer-based lesson packages are complete, they will be lodged with the National Film Library where they will be available to any teacher at any school; (c) develop didactic strategies for the implementation of computer technology in the curriculum; and (d) provide a valuable support mechanism for teachers training in the cascade. In the years ahead it is hoped that, as more equipment becomes available and more trained teachers are able to avail themselves of pre-tested software modules, the integration of computer technology into daily subject teaching will occur naturally in the schools participating in the project.

There are both positive and negative aspects of the project. The positive aspects of the project are that:

1. Fourteen hundred teachers a year receive computerliteracy training in the Cape Province.
2. The project has raised the level of awareness among teachers of the computer as a teaching aid and has increased the frequency of use in the classroom.
3. Many schools have undertaken fund-raising drives to supplement the computer equipment provided.
4. Standardisation on one software package that can be used for training purposes has been completed.
5. MS-Works provides a development path from a DOS version to a Windows version.
6. Ready made computer-based lessons for teachers are available.
7. Several schools are already experimenting with more advanced technology such as CD-ROM, downloading satellite weather data, and computer-based measurement in the science laboratory. These individual efforts are often in conjunction with commercial enterprises.

In contrast, the negative aspects of the project are that:

1. The process of supplying equipment is slow.
2. Schools may end up with a variety of equipment from ATs to 486s.
3. The process of mastering the new technology in the project schools has taken longer than initially expected.
4. All schools in South Africa can not be involved at this time.

Future Developments

A single Education Department will be established by April 1994. Between eight and ten regional educational authorities will be established, all answerable to the central education department which will provide for one examining body, one curriculum body, and one education policy.

Education systems exist within social and political systems (Hawkridge, 1987). Until South Africa completes the changes it is undergoing in its social and political systems it will be difficult to assess the exact positioning of the CISC project within the new structures. It is encouraging to note that policy speeches by major political leaders indicate a movement away from academically based education towards vocationally oriented education. This will pave the way for the introduction of subjects such Technology and Information Systems as subjects in the secondary curriculum.

No matter what the changes, in-service training of teachers will remain a major priority — it is generally accepted that currently 30 - 40% of teachers are underqualified. Clark, Hosticka and de Neuilly Rice (1993) clearly illustrate the problems facing education in the new South Africa. Distance education, tele-tuition, and computer-based education will all need to play a role. The lessons learned through the success of the current Computers in Schools and Colleges Project will provide a model for the use of computers in education in the new South Africa of the 90's.

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Preparing Educationally Computer Literate Educators for the "New" South Africa

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The University of Port Elizabeth is one of two universities in South Africa to offer a two-year, part-time, Further Diploma in Education in Educational Computing. The diploma program was initiated in January 1993 with a multi-cultural group of 40 in-service teachers. For the purpose of this diploma, the term "educational computing", is used as an all-inclusive and neutral concept, incorporating all the modes of computer use in schools.

Background

A report on a South African government-initiated investigation into computer literacy training in South Africa, undertaken jointly by the National Training Board (NTB) and the Human Sciences Research Council (HSRC), was published on 23 August 1991 (Department of Manpower, 1991). This investigation resulted in the formulation of an action plan/strategy to ensure that, by the year 2000, all school leavers would be functionally computer literate — an overly ambitious goal given the realities of South Africa.

The Educational Renewal Strategy (ERS) and the National Education Policy Investigation (NEPI) also support the need for teachers to be educated in the applications of information technology in schools (Department of National Education, 1992; National Education Co-ordinating Committee, 1993). The intent is to restructure the South African education system to correct past imbalances.

In 1992 the ethnic composition of the 310, 000 teachers in South Africa was as follows: 65% Black, 18% White, 13% Coloured (mixed race), and 4% Indian (National Education Co-ordinating Committee, 1993). Furthermore, research undertaken by the authors (Bean & Cowley, 1993) indicates that amongst teachers in nearly 400 schools:

1. Only 10% of the White, Coloured, and Indian teachers (taken as a group) and less than 1% of the Black teachers had taken a computer course during pre-service training.
2. Nearly 10% of White, Coloured, and Indian teachers (taken as a group) received in-service computer training and/or undertook part-time studies in computer literacy whereas only 2% of their Black counterparts did so.
3. Less than 2% of the Black teachers use a word processor for 2 hours or more per week but 15% of the other group does.

It is clear that few South African teachers have sufficient skills in the educational use of computers and that there is a definite need for training in this field.

Rationale for Curriculum Content

The diploma program is a response to the needs and problems discussed above. The primary aim is to equip and prepare in-service teachers to act as computer coordinators and innovators in their respective institutions and this entails:

1. Promoting the use of computers in all school activities.
2. Directing and managing computer literacy programmes for students.

3. Assisting their colleagues in becoming "educationally" computer literate through in-service training, workshops and support.
4. Guiding cross-curricular educational computing applications in all subject areas.
5. Co-ordinating the use of computers in administration.

The secondary aim of the diploma program is to expose teachers/lecturers (our students) to new developments in educational computing (e.g., international trends, multimedia applications, didactical and methodological principles). Niess (1991) compared the internationally accepted competency guidelines drafted by the Northwest Council for Computer Education (NCCE) and the Oregon State University in 1989-90 with those drafted by NCCE in 1983. In answer to the question of what teachers should know about computer technology in order to be competent computer using teachers in the 1990's, she suggested the following synopsis of competencies: all teachers in the 90's must (a) be comfortable with computer technology, (b) be knowledgeable about the impact of computer technology on and in society, and (c) teach using computer technology.

Diploma Program

A comparison of the primary and secondary aims of the Diploma with Niess' synopsis of competencies indicates that Diploma satisfies these criteria. This can be seen by examining the program structure, student selection, and the hardware and software utilized.

Course structure

Two years of part-time study:

First Year	**Second Year**
Educational Computing 1	Educational computing 2
Computing Practice 1	Educational computing 2
Methodology of Educational Computing 1	

Selection of Students

The minimum admission requirements for the program are that applicants must be professionally qualified teachers with an approved training of at least M+3 (12th grade plus three years post-school teacher education). A marketing drive, targeting all schools within an 80 kilometer radius of the University, drew tremendous interest from teachers across the cultural spectrum. Applications ranged from junior school teachers to lecturers at technical and teacher-training colleges. Most of the applicants were White and Coloured teachers/lecturers. This teacher/lecturer profile can be attributed to the active promotion of computer integration in their schools and colleges.

We selected 40 students for the diploma program based on (a) available facilities and manpower constraints; (b) a diversity of subject areas, school phases, and cultures; and (c) to assist certain schools and colleges who had appointed a non-educationally computer literate staff to train their students in Computer Literacy!

Hardware and Software Utilised

The students have access to a laboratory of 40 33 MHz, 486SX workstations, all with SVGA displays and 120 MB local hard disks, networked together. Software includes a standard integrated package, a variety of open-ended and closed CAL software, a school administration system, and system utilities. These facilities have proved to be adequate for our students' educational needs.

The Diploma - One Year On

It has been very interesting to teach in the diploma program. The interaction of the students with course material and each other reflect the challenges and problems of a society made up of diverse groups in the throes of fundamental change.

When the diploma started, students cited two reasons why they had enrolled. They either had an interest in educational computing and a desire to improve their qualifications or they believed that a further qualification would lead to an increase in salary. Those students regarding one as more important seem more motivated than those who regard two as more important, although the gap between the two groups has narrowed.

As a group, the students have become more knowledgeable and aware of the possibilities of educational computing. A substantial number of the students have bought, or are planning to buy, their own personal computers and software. Some students have assumed the roles of innovators and catalysts for change in their institutions and are training fellow educators and/or are developing simple information systems.

The class is still divided on racial grounds, with students tending to associate with those of their own race (Whites with Whites, Coloureds with Coloureds, Blacks with Blacks) when working in groups and doing practical work, despite being encouraged to interact by the lecturers. Inter group co-operation is increasing, however, and there is a friendly and positive atmosphere in the class, with no apparent inter-racial friction.

Progress in the Diploma has tended to be most rapid for the White students, less rapid for the Coloured students, and least rapid for the Black students, although these differences are decreasing. They are due to historical and current disparities in access to educational resources in general, and to computing resources in particular. These differences are going to require a lot of time, effort, and money to eliminate.

Conclusion

Teaching in the diploma program has been a rewarding experience for the authors. It will be interesting to observe the evolution of this program in the years to come, as well as the contributions to educational computing that students awarded the diploma will make.

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Computers in South African Schools: Quo Vadis?

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The future of computers in South African schools is clouded by the many uncertainties surrounding the nature of the future educational dispensation in what is popularly referred to as the "New" South Africa.

The Present Situation

The extent of the current education crisis in South Africa is enormous. The profile of the education level of the population currently in employment consists of 30% with no formal education, 36% with only primary education, 31% with secondary school education, and 3% with tertiary education (Hofmeyer and Buckland, 1992). According to Du Preez (1991), the South African population is expected to double from approximately 35 million in 1991 to approximately 70 million in 2020. Furthermore, he forecasts that the Black school population (now 75% of the total school population) will increase threefold from approximately five million to 15 million over the same period.

As National Education Minister Piet Marais has indicated, because the number of students increases by about 500, 000 per year an extra 500 schools are needed annually (E.P. Herald, 1993). This problem is exacerbated by the fact that, in 1992, 20% of the total South African national budget was already allocated to education, the third highest in the world based on percentage of total budget (National Education Co-ordinating Committee, 1993).

According to Mills (1990), the available statistics reveal that the educational crisis in South Africa cannot be overcome by conventional or traditional methods. Over and above the ever-increasing financial resources that must be provided new and innovative teaching methods, including the application of technology, need to be incorporated.

Current South African educational policy, largely because of the decentralisation of educational policy making, lacks consistency and coordination in respect to computers in education (Bean, 1992). Computers, (some of them obsolete) have been provided to schools in an uncoordinated fashion. Some computers have been provided through segregated departments of education, others via donations, and some through the efforts of teachers or parents in individual schools. As would be expected, schools serving more affluent communities have fared best, quickly widening the gap between privileged and underprivileged pupils. The use of computers in White schools in particular has become widespread, with many of these schools acquiring computer equipment on an ad hoc basis.

At the other end of the scale, however, Black schools (which constitute the vast majority of schools in South Africa) are in a very unfortunate position. These schools have not received any computer equipment from their respective departments and few are in a position to enjoy the 'luxury' of computers. Contributing factors include socioeconomically disadvantaged parents, minimal private sector support, overcrowded schools, and the absence of electricity in many rural schools.

One positive aspect, though, does emerge from the study of these imbalances. The lessons learnt through the computer integration initiatives of certain departments of education and tertiary institutions in South Africa (Bean, 1992) can serve as a foundation for a future national computer integration policy and, thereby, eliminate costly mistakes and time-consuming planning.

The Future: The General Election, April 1994

Drastic changes are due to take place in the education system of South Africa after the first fully democratic elections for a Government of National Unity on 27 April 1994. It is anticipated that South Africa will be divided into six or seven regions, each receiving a certain degree of autonomy in the execution of a national education policy. The burning educational questions facing the soon-to-be-elected interim government include:

1. How can equal educationalopportunities be provided?
2. What educational standards can be applied/afforded?
3. How can the problem of illiteracy be tackled?
4. How can an adequate number of qualified teachers be provided for the future?
5. How can existing under-qualified teachers be adequately trained through the INSET programme?
6. Will the interim government find constructive alternatives for the millions of young people (the "lost generation") who have been denied an education?
7. How can a high level of basic education, on which to build skills needed for economic growth, be structured?

Two very important documents concerning a future national education policy for South Africa were published during 1992 and 1993. The Educational Renewal Strategy (ERS) and the National Education Policy Investigation (NEPI) clearly state the views of two major role-players in the forthcoming elections — the present government and the African National Congress (Department of National Education, 1992; National Education Co-ordinating Committee, 1993).

The ERS and NEPI documents do not deal with the use of computers in schools in great detail and it would therefore be pointless to attempt to predict the educational computing policies of these parties by attempting to "read between the lines" of these documents. It is clear, however, that one of the most important precondition for the application of computers in the new education system is the development of a comprehensive plan addressing the future integration of the current fragmented system.

A National Policy on Computers-in-Schools for South Africa

The present situation regarding computers in schools in South Africa typifies how damaging the lack of a national policy based on a dominant rationale, i.e., social, vocational, pedagogic or catalytic (Hawkridge, 1990) can be. The new Ministry of Education in South Africa must base its computers-in-schools policy on one or more of the rationales listed above. Although the government may initially lack the money to do as they wish as well as being unable to give computers high priority, they can make important policy decisions and determine at what stage computers should receive a higher priority. The following two key issues, in particular, relating to computers-in-education need to be addressed as a matter of urgency.

Teaching *with* Computers

Should computer-based education be considered an important way to improve the quality of teaching and learning in South African schools and address the high drop-out rate of students from disadvantaged communities? In White education, at present, approximately 82% of students entering school pass Standard 10 (12th grade). The corresponding figure for students in Black schools, however, is as low as 20% (Department of National Education, 1992). The shortfall of adequately trained teachers is often mentioned as the primary cause of this discrepancy. In the South African context the effectiveness of teachers can be improved by supplementing their knowledge and improving their ability to handle large groups of students at a time. The experience of the University of the Western Cape is of great interest in this regard. As Mehl (1991) indicates, "two tutors easily manage 1000 participants per week. It continues to be striking how easily students from the most disadvantaged backgrounds in the Cape Peninsula adapt to the use of high technology."

Teaching *about* Computers

Should information technology be included in the national curriculum? At a conference on the restructuring of education in South Africa in 1993 the following statement was made: "The school curriculum is like the national flag; it is the most concrete and tangible expression of national values" (Centre for Science Development, 1993, p.5). The South African labour market is increasingly demanding workers with the necessary literacy skills. This includes being computer literate. It is evident from international trends that skills related to computer technology are increasingly being included in core curricula (Department of National Education, 1992).

Implementing Computers in Education: Success Factors

It seems likely that the government elected in April 1994 will answer *yes* to both the above questions. *When* and ***how*** can only be answered by gazing into a crystal ball at this stage! According to Moiloa and Perold (1993) "the introduction of educational technology in South African education will require, like everything else, a democratic approach underpinned by the principle of equity" (p. 22). Nevertheless, the following critical success factors for educational computing initiatives in general, and computers-in-education specifically, can be identified and should be addressed by the new government.

Political Influence

Politics, education, and the political influence on education are always inextricabily intertwined. This is even more so the case in the atmosphere of liberation currently being experienced in a South Africa in transition. A legitimate and politically validated education policy is crucial for South Africa's progress towards an education

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system in which all students enjoy equal educational opportunities and a quality education. If political influence is exerted by means of destructive strategies (i.e., overemphasising the socio-economic factors for political gain) the continued availability of educational opportunities, not to mention quality education, may be undermined.

Economic Growth

Every attempt should be made to increase South Africa's poor rate of economic growth, to raise the standard of living of its inhabitants, and to make more money available for education. As the Minister of National Education indicated, South Africa would only have a chance of financing an education system which provided nine years of compulsory education if there was a growth rate of at least three percent in GDP and if six percent of GDP went to education (E.P. Herald, 1993). Without a stronger and stable domestic economy to employ school leavers and other learners, the long-term benefits of education for all will be severely constrained (Centre for Science Development, 1993).

Planning

A sound national computer integration policy must be formulated in consultation with all interested parties and the broader community (the stakeholders). This implies top-down planning from the macro to the micro levels, guided and directed by the broad goals of a central education strategy.

Establish Private Sector Interest In Education

If it is expected that a national education strategy should support a central economic strategy (i.e., full employment), and taking into consideration the demands for a market oriented education strategy, it goes without saying that the private sector should establish a substantial interest in education. Local and international investments in educational initiatives should be encouraged, including computers-in-education. In addition, coordination must be centralised. The involvement of the private sector is the only obvious way, from a financial stand point, to make an information technology policy in education practical.

Prioritise Teacher Education

Educational computing training should be included as one of the minimum criteria requirements for teacher education on a national basis. Educationally-oriented computer literacy training programs must also be developed for all practicing teachers. Empowering teachers to apply computers in administration, materials preparation and production, assessment, and teaching support are likely to improve their efficiency and productivity (Moiloa and Perold, 1993).

Maximum Computer Literacy For The Population

If the road to success in education lies in technology it is essential that computer literacy be established at all levels of the community. One solution would be the creation of "Community Learning Centres", staffed by specially trained personnel, that would offer access to computer facilities to the broad community. Accredited certificate and/or diploma courses in information technology or basic computer literacy at school level should also be offered at schools and tertiary institutions where the necessary hardware, software, and expertise are available. This will provide an opportunity for all students to obtain a qualification that would make them more employable upon leaving school.

Utilise Existing Projects, Initiatives, and Skills

Currently successful computers-in-schools projects, outreach programmes, and other initiatives by tertiary institutions should be supported in order to keep the momentum going. In addition, these initiatives must be extended to as many Black schools as possible. The critical lack of appropriate computer-assisted learning (CAL) courseware, specifically designed for South African requirements, should be dealt with at central government level. Existing development and expertise in this field, as well as the distribution of CAL software, should be coordinated under the guidance of a national "software clearing house" functioning under the auspices of the National Education Department.

Employ Information Technology as a Facilitator in Education Processes

Financial and resource limitations in South Africa necessitate provision for learning outside conventional, formal classroom contexts. Independent study is an important element of a future education system and information technology can facilitate this. In this regard, the following modes should be used (Mehl, 1990; Lippert & Knoetze, 1991; Mills, 1991, McGregor & McGregor, 1992): (a) interactive computer-assisted learning, (b) distance education, and (c) small-group and cooperative learning processes.

Conclusion

There are a vast number of needs competing for priority in South Africa. The attempt to redress decades of inequality will involve a massive input of money, innovative effort, and time. Considering the current state of schools in many areas, particularly rural areas, a large portion of funds available will have to be spent on critical areas like buildings, other facilities, books, and salaries (Clark, Hosticka & Rice, 1993). The responsibility for financing education should be distributed in such a way that the State, local authorities, unions, employers, NGOs (non-governmental organisations), parents, and the local community all contribute their share (Centre for Science Development, 1993).

There are extremely good reasons for investing in information technology applications in the field of education. In addition, because information technology is currently the only resource not influenced by inflation, any country, community, or organisation not maximizing the use of information technology will suffer from an ever-widening deficit in contrast with countries utilising it in a directed manner. This is a situation that the 'New' South Africa in general, and education in South Africa specifically, cannot afford.

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Teacher Training for Information Technology in Four Nations

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In the past decade there has been an impressive growth in the use of computers in schools all around the world, and a rapid increase in the need for teachers trained in the proper use of information technology (Pelgrum & Plomp, 1991; Saloman, 1989). Computer-related educational practices for China, Japan, Thailand, and the United States of America (USA) are described in this paper, with a focus on existing teacher training goals and needs in the four nations. Comparisons are couched within a two-dimensional framework: East versus West and "developed" versus "developing" nation status.

Overview of Education Systems

The basic structures of the public education systems in China, Japan, Thailand, and the USA are similar in that all four nations offer 12 years of pre-university schooling beginning at age six. As of 1993, all utilize computers in education to some degree. There are also many differences among the systems. China and Thailand require six years of school attendance, while Japan requires 9 years. In the USA states vary in their requirements from 8 to 12 years (The World Book Encyclopedia, 1993). The educational systems in China, Japan, and Thailand are centralized, while the USA system is decentralized across 50 states.

Computer Diffusion Rates

Computers were rapidly introduced into all levels of USA education during the 1980s. Ninety-five percent of all elementary and secondary schools possessed at least one computer by the fall of 1987 (Quality Education Data, 1989) and diffusion rates had reached 100% by 1989 (Pelgrum & Plomp, 1991).

In Japan, the introduction of computers into vocational upper secondary schools was also quite rapid during the 1980s, but diffusion rates for elementary schools, lower secondary schools, and non-vocational upper secondary schools were much lower than in the USA during the same time frame (Knezek, Miyashita, Sakamoto, 1990; Monbusho, 1989). As of 1992 nearly 100% of the Upper Secondary schools, 94% of the Lower Secondary schools, and 58% of the elementary schools had computers (Monbusho, 1992).

Diffusion rates for China were similar in form to, but lagged behind, Japan. Approximately 27% of the secondary schools in China had computers in 1985, with this figure rising to 61% by 1989 (Pelgrum & Plomp, 1991). According to statistics released by the State Education Commission, there were a total of 10,000 computer-using schools by 1992.

In Thailand, only 30% of the teachers surveyed in 1991 worked in schools which had computers (Loipha, 1992). Eighteen percent of the schools possessed 1 to 10 computers and 12% possessed more than 10 machines. Seventy-five percent of the 527 elementary and secondary school teachers responding had never used computers in classroom activities. By 1993, however, most secondary schools offered an elective informatics course and possessed a laboratory of computers to support these activities.

National Initiatives for Computer Education

USA

Nineteen eighty-two was the year many schools in the USA began using computers (Pelgrum & Plomp, 1991). During the decade of the 1980s many individual states adopted elementary and secondary curricular requirements for computers and established teacher training programs. In 1990 the Accreditation Committee of the International Society for Technology in Education (ISTE) began formulating universal guidelines in the area of information technology for submission to the US National Council for Accreditation of Teacher Education (ISTE Accreditation Committee, 1991). Proposed ISTE recommendations include competencies for teachers in four areas: (a) foundations for all teachers, (b) computer/technology literacy for teachers of computer literacy, (c) educational computing and technology specialty for computer coordinators and other technology leaders, and (d) computer science education for teachers of computer science in secondary schools. These standards will apply to all programs which lead to a degree or an endorsement (training certificate). Because a large number of existing teachers in the USA are pursuing higher degrees or endorsements in information technology while they are teaching in another field, the standards will commonly apply to in-service as well as pre-service training. Traditional short-course in-service training is coordinated by each state's education agency and is not likely to be formulated into a national curriculum in the near future.

Japan

Many schools in Japan first began using computers in 1985 (Pelgrum & Plomp, 1991). A New Course of Study which extensively revised elementary, lower secondary, and upper secondary curricula with respect to internationalization, the information revolution, and individualization was announced in 1989. A major revision in the Teacher Certification Law also took place, which introduced a new, required course on Educational Methodology and Technology for all teacher trainees entering the university beginning April, 1990. This course includes skills in three areas: practical instruction competencies, instructional media utilization, and information utilization (Arizono, Ikuta, Inoue, Nanbu, & White, 1990).

Since only a small percentage of new teachers enter the workforce in Japan each year, most computer-using teachers are receiving their training through in-service programs (Sakamoto & Stern, 1988). Part 1 of the Basic Course for in-service training, adopted in June, 1990, includes the general overview for enhancing fundamental knowledge and skills in each medium and the knowledge required for the classroom application of six different types of media: slide, overhead projector, broadcast, video, film, and the computer. Part 2 of the Basic Course is related to the knowledge and skills necessary for teacher training. Since 1990, Part 1 of the new Basic Course has been required for all teachers and leaders in educational institutions, while Part 2 is designed for the leaders in prefectures and big cities. A detailed description of the content for these and other courses is available in Sakamoto and Knezek (1991).

China

The Chinese Government in 1982 began its first attempts at offering computer lessons at five secondary schools in Beijing, and many schools in China began using computers by the end of 1986 (Pelgrum & Plomp, 1991). Early in 1983, the Ministry of Education called for a National Computer Education Conference to create an outline of a teaching program for computer education in the secondary schools. It focused on computer principles and programming in BASIC. Later, in 1986, use of computer application software was added to the main outline. In 1987 the National Research Centre of Computer Education for Primary and Secondary Schools was set up under the Basic Education Department . In 1991 the Centre adopted and published the Instruction of the Computer Course for Primary and Secondary Schools, making it an independent course for students. In 1992, the State Education Commission set up the Leading Group for Computer Education in Primary and Secondary Schools to administer and supervise primary and secondary computer lessons. The Evaluation Committee for Computer Education Software was also formed in 1992 under the leadership of the State Education Commission.

With respect to the training of teachers and administrators the State Education Commission has made special efforts to gradually open up in normal colleges and universities, departments and specialties to offer a course on computer science and to enroll graduate students into special lines of study so that afterward they can take CAI and CMI-related work as life careers. Nevertheless, the two main impediments to more rapid introduction and utilization of computers in Chinese education continue to be the lack of technology-literate teachers and the shortage of other qualified personnel.

Thailand

Although computer instruction has taken place in Thailand for the past 20 years (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 1985), most use of computers in education came after the advent of microcomputers. In 1983 some secondary schools in Thailand acquired microcomputers and began offering elective courses. In 1985 the Ministry of Education implemented a computer curriculum for the upper secondary school level throughout the country. The Institute for the Promotion of Teaching of Science and Technology in Thailand initiated a pilot project in 1987 to encourage the integration of computers in teaching mathematics and physics at the upper secondary level. As of 1990, 15 universities and 36 teacher's colleges in Thailand provide computer courses for both graduate and undergraduate students. Thailand as a whole, however, is not far advanced in its use of computers in the school system.

Trans-National Trends

Education Systems

With respect to national systems of education, the previously mentioned division along centralized versus decentralized lines is believed to be largely an East versus West distinction, or, at least an American versus "world norm" distinction (most European nations also have centralized education systems). The differences in required levels of school attendance are believed to be the result of "developed" versus "developing" nation status.

Computer Access

There are great discrepancies in the availability of computers among these four nations. Almost all USA students now have access to computers. Most Japanese students also have computer access. Many secondary school students in China and Thailand have computer access, but most Thai elementary students do not. However, the pattern for introducing computers into pre-university education is similar for the four nations, in that high schools received computers first, followed by junior high (lower secondary) schools, followed by elementary schools.

The similarities in the "high school first" national diffusion patterns are believed to be primarily due to more focused curricular offerings at this level, software availability, and the existence of teachers willing and able to work with computers. The discrepancies for computer access are believed to be the result of both "developed" versus "developing" status, in the case of overall trends, and the Eastern tendency for contemplative consensus planning versus the Western tendency for trial-and-error individual initiatives. The latter accounts for the slower diffusion pace in Japan compared to the USA.

Instructional Purposes for Computers

In the 1991 survey of application types for Thailand, drill and practice was used most often (25% of teachers responding) followed by tutorials (16%) and problem-solving (10%). Simulations were least used (5%) (Loipha, 1992). This high utilization of drill & practice and low utilization of simulations is consistent with findings by Pelgrum and Plomp (1991) across 18 other nations, including China, Japan, and the USA.

The content areas in which computer use has been emphasized are also generally consistent across the four nations. For example, in 1985-86 roughly 75% of the use of software in American schools was for math, science, mother tongue, or informatics (Becker, 1985; Smith, 1986). For Japanese schools in 1988, approximately 80% of the use was for math, informatics, science, or mother tongue (Monbusho, 1989). Among Thai teachers in 1991, the large percentage used computers in connection with mathematics, science, and informatics (Loipha, 1992).

Differences among nations lie in emphasis, as evidenced by the great variations in the extent of 1989 computer use in secondary schools for subjects such as informatics (China, 92%; USA, 90%; and Japan 50%) or mother tongue (USA, 57%; Japan, 13%; and China, 2%) (Pelgrum & Plomp, 1991, p. 9). This may be partially due to the "universal language" nature of subjects such as math and science, which makes software adaptability and transportability straightforward. Conversely, the "non-universal language" nature of mother tongue software certainly must retard international development and diffusion of quality programs.

Teacher Interest in Technology-Enhanced Instruction

USA teachers' attitudes toward computers have slowly improved over the past 15 years. In 1976, 55% thought the computer was dehumanizing and had attitudes less positive than the general public . In 1980, most supported the concept of computer literacy, 40% still felt anxious just talking about computers, and 90% judged themselves incompetent to teach with or about computers. By 1987, on the other hand, teachers were generally enthusiastic and felt the benefits outweighed their anxieties (Dupagne & Krendl, 1992).

A similar but more rapid evolution appears to have taken place in Japan (Arizono et al., 1990; Knezek et al., 1990). Many Japanese teachers initially saw the computer as an aid for student mastery of new knowledge and a way to help slow learners (Sakamoto & Stern, 1988). Nevertheless, by 1989, the major barriers to the wider use of computers for instruction listed by educators in Japan, China, the USA, and 15 other nations were: (a) shortage of hardware, (b) shortage of software, (c) insufficient teacher training, and (d) insufficient time for teachers to prepare to use computers in their lessons (Pelgrum & Plomp, 1991). Only 1.3% of the Thai teachers surveyed in 1991 were "not very interested" in receiving formal training about computer use (Loipha, 1992). Opposition by teachers no longer seems to be a barrier to wider computer use.

Approaches to Teacher Training

Across the four nations studied, approaches to teacher training for information technology appear to fall into two categories: (a) short term, specific skill training, which is commonly associated with in-service training programs; and (b) long term professional career development, which normally involves credit-bearing coursework which may lead to a graduate degree. The former approach is common in Japan and Thailand, while the latter is common in the USA (Loipha, 1992; Sakamoto & Knezek, 1991). For example, in Japan during the four years spanning 1988 to 1992, all sixteen thousand lower secondary technology education teachers received 10 days of in-service preparation for teaching Fundamentals of Informatics in the new national standard course of study (Murata & Stern, 1993). In Northeastern Thailand, Loipha (1992) found that 60% of the elementary and secondary teachers in schools with computers had received formal in-service training. In general, each of the four nations employs some short-term and some long-term training, with differing degrees of emphasis.

Potential Future Problems

Two kinds of problems are so pervasive among the nations studied that they are not likely to be resolved in the near future. These problems are: (a) poor dissemination of pedagogical techniques for integrating computers into education; and (b) continuing shortages of hardware, software, and computing-competent teachers. A third problem, low use by teachers who have resources and have received training, is also known to exist in the USA and may soon emerge in other nations.

One reason for the scarcity of pedagogical techniques in training programs may be the shortage of computer experience among professional teacher educators. Lomerson (1992) concluded after reviewing the existing literature in the USA that "the proportion of computer literate higher education faculty is quite small" (p. 5) and "there is little, if any mandate or incentive beyond personal inquisitiveness for existing faculty to achieve even this minimum level of technological literacy" (p. 5). In Thailand, which has an extensive system of teacher's colleges, Cheamnakarin (1992/1993) surveyed 204 faculty members at 30 campuses and found neither age, gender, extent of prior computer experience, nor number of computer training workshops attended affected teacher-training faculty's perceptions of the importance of computers in education. Apparently many teacher-training faculty do not necessarily model, nor do they particularly wish to model, computer-enhanced pedagogical techniques with their students who are destined to become teachers and teacher-trainers. It is, therefore, not surprising that training is lacking in this area.

Current low-usage trends in the USA may foreshadow similar difficulties in other parts of the world. Although Pelgrum and Plomp (1991) found that in the USA there has been "a steady (although slow) increase in the number of teachers using computers over years" (p.13), others have questioned how much teacher training is actually put to good use. For example, in a USA survey on the use of computers in fifth through ninth grade classrooms, Dickey and Kherlopian (1987) found that 70% of the teachers had access to computers, but a large percentage with computer access reported they did not use them. Schug (1988) found that only about 18% of a sample of high school social studies teachers surveyed actually used computers instructionally, even though almost 50% had received basic training in the use of computers and expressed positive attitudes toward the use of computers in the future. In a statewide training program for teachers, Stieglitz and Costa (1988) found that only about one-half of the 1,000 participants surveyed actually used computers in class after their in-service training. This was in spite of the fact that 89% felt computers had substantial benefits for students. Apparently even the combination of readily available resources, positive teacher attitudes, and formalized teacher training still does not necessarily lead to high levels of computer use in schools. Further research is needed to determine what other barriers remain.

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Effects of College, Gender, and Prior Computer Experience on Attitudes toward Computers among College Students in Taiwan

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The microcomputer as a new technology has been widely used in education. The number of computers in use in schools has increased at an unprecedented rate. Wright (1984), for example, reported that in 1982, 38% of schools in the United States of America (U. S.) had computers, but in 1988, 91% of schools had computers (Ordovensky, 1989). By the end of the 1980s the number of microcomputers in use in schools of U.S. was estimated to be 2.4 million (Becker, 1990).

Education in Taiwan has also been influenced by the increasing use of technology. Computer education in Taiwan started with the development of Computer Assisted Instruction (CAI). From 1976 to 1983 CAI had mainly been developed in some universities. After that, the development of CAI was extended to middle schools, elementary schools, and some training institutions. The types of computers used for CAI ranged from mainframe computers to microcomputers (Wu, 1992). The number of CAI courseware developed by either public research institutes or private commercial parties is more than three thousand so far.

Along with the increasing use of computers in education and society, most colleges and universities in Taiwan have also offered some introductory computer courses as prerequisites. In general, the content of these courses contains the basic concept and operation of computers as well as software. Some instructors may include the introduction of programming languages in their courses as well.

While microcomputers have been increasingly used in schools, students' and teachers' attitudes toward them need to be studied. Studies have identified significant relationships between computer attitudes and computer literacy among college students (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Marcoulides, 1988; Wiggins, 1984). Clement (1981) reported that, in general, students' attitudes toward computer-based courses have been found to be positive among students in junior high schools, high schools, community colleges, and colleges. Positive attitudes increase the prospect for achievement in any academic endeavor, whereas negative attitudes make achievement of competence less likely (Loyd & Gressard, 1984).

The major purpose of the present study was to examine the effects of types of colleges, gender, and prior computer experiences on computer attitudes for college students in Taiwan. More specifically, this study attempted to examine the effects of (a) types of colleges (i.e., management college and teacher college), (b) gender, and (c) prior computer experience (i.e., less than 3 months, 3-6 months, 6-24 months, and more than 2 years) on computer attitudes.

Method

Subjects

The subjects who participated in the present study were 918 students from two colleges in Taipei, Taiwan. The first college was a private management college. A total of 615 subjects participated in the present study and were selected from 7 different departments of this college. The remaining 303 subjects were from a national teacher college with a major educational goal of preparing elementary school teachers. These students were also selected from different departments. The students selected at each department represented a broad spectrum of backgrounds and academic interests. Six hundred fifty-seven or about 72% of the subjects were female while 261 or about 28% of the subjects were male.

Instrument

The instrument used in the present study was a Chinese version of Computer Attitude Scale (CAS). The original CAS was developed by Loyd and Gressard (1985) and was designed to measure students' attitudes toward computing. The Scale consists of 30 Likert-scale type questions for three subscales: computer anxiety, computer confidence, and computer liking. Each subscale consists of ten items and presents positively and negatively worded statements. The scores from the three subscales are then added together to produce a computer-attitude score. The Scale has been found to be reliable and valid, and has been previously used with students at varied school levels (Loyd & Gressard, 1984; Loyd & Gressard, 1986; Loyd & Loyd, 1988; Massoud, 1990, 1991). The Chinese version CAS was a translation of the original CAS. As a check for accuracy of the translation, the Chinese version CAS has been reviewed and verified by two English instructors from colleges.

Procedures

At the beginning of the Spring academic semester, 1992, all 918 subjects completed the 30-item Chinese version CAS. The data were collected and coded. A 2 x 2 x 4 analysis of variance (ANOVA) was used to investigate if there were any statistically significant differences on students' attitude toward computers: (a) between colleges (i.e., the management college and the teacher college); (b) between gender; (c) among students who had different level of prior computer experience (i.e., less than 3 months, 3-6 months, 6 -24 months, and more than 2 years); and (d) the interactions among these factors (i.e., colleges, genders, and prior computer experience).

Results

Major three-factor ANOVA

Table 1 summarizes mean scores for the three-way

Table 1
Summary of Computer Attitude Mean Scores

Subscale/ Computer Experience	Teacher College		Management College	
	Male	Female	Male	Female
Anxiety				
0-3 Months	26.70[a]	25.92	27.48	25.78
	(57)[b]	(49)	(25)	(49)
3-6 Months	26.78	25.83	26.88	26.17
	(46)	(47)	(8)	(107)
6-24 Months	28.19	26.97	27.44	27.44
	(27)	(50)	(55)	(112)
2 Years+[c]	33.06	26.91	32.04	27.26
	(16)	(11)	(27)	(232)
Confidence				
0-3 Months	27.21	25.51	28.28	24.84
3-6 Months	26.26	25.21	27.00	25.38
6-24 Months	27.89	26.34	27.27	26.49
2 Years+	32.13	27.46	30.22	26.99
Liking				
0-3 Months	27.75	26.53	28.60	26.59
3-6 Months	26.41	25.85	25.25	26.92
6-24 Months	26.78	26.36	26.91	27.98
2 Years+	28.81	26.64	31.04	26.38
Total				
0-3 Months	81.67	78.00	84.36	77.20
3-6 Months	79.46	76.89	79.13	78.47
6-24 Months	82.85	79.66	81.62	81.91
2 Years+	94.00	81.00	93.30	80.62

Note.[a] The possible maximum score for each scale is 40.
[b] The number of subjects is presented in parenthesis.
[c] 2 years+ indicates more than 2 years.

analysis of variance. Overall, participants' scores ranged from 25 (63%) to 33 (83%), out of the maximum score of 40, on each subscale, and from 76 (63%) to 94 (78%), out of 120, on total.

A summary of the three-way ANOVA is presented in Table 2. Results indicate that there were significant main effects (a) between gender on anxiety, confidence, liking, and total score; and (b) among prior computer experience on anxiety, confidence, liking, and total score. Significant interactions between gender and computer experience were also found on anxiety, confidence, liking, and total score. No other main effects and interactions were found.

Gender

A follow-up analysis was performed for gender. Results are presented in Table 3 and show that male students scored significantly higher than female students on all 3 subscales: anxiety, confidence, and liking, as well as total score.

Computer experience

For computer experience a follow-up analysis was employed. Table 4 summarizes data for the ANOVA on computer experience. Results indicate that significant differences were found among students with varied prior computer experience on anxiety, confidence, and total score. No significant difference was found on liking. For anxiety, the post hoc (Fisher's Protected LSD) test showed that students with prior computer experience of 0-3 months or 3-6 months scored significantly lower than students with prior computer experience of 6-24 months or more than 2 years. No significant differences were found between students with experience of 0-3 and 3-6 months, and between 6-24 months and more than 2 years.

The post hoc test for the subscale confidence showed

Table 2
Summary of the Three-Factor-ANOVA (College x Gender x Length of Experience)

Source of Variation	*df*	Anxiety		Confidence		Liking		Total Score	
		MS	*F*	*MS*	*F*	*MS*	*F*	*MS*	*F*
College(A)	1	.03	.001	4.45	.27	36.92	1.96	17.03	.13
Gender (B)	1	479.24	21.01***	584.43	35.56***	124.54	6.61*	3274.83	24.45***
Length of Experience (C)	3	236.59	10.37***	179.72	10.94***	67.65	3.59*	1249.18	9.33***
A X B	3	6.69	.29	.04	.002	.36	.02	8.92	.07
A X C	3	2.74	.12	11.64	.71	5.67	.30	10.27	.08
B X C	3	123.96	5.44**	44.47	2.71*	89.86	4.77**	697.39	5.21**
A X B X C	3	10.29	.45	17.01	1.04	29.87	1.58	92.94	.69
Error	902	22.81		16.44	18.85			133.94	

*$p < .05$ **$p < .01$ ***$p < .001$

Table 3
Summary of Mean, Standard Deviation, and ANOVA on Gender

Variable	Male ($N = 261$)		Female ($N = 657$)		
	Mean	SD	Mean	SD	*F*
Anxiety	28.05	5.41	26.77	4.67	12.72***
Confidence	27.84	4.16	26.21	4.16	28.70***
Liking	27.65	4.20	26.73	4.49	8.09**
Total	83.53	12.13	79.71	11.71	19.50***

** $p< .01$ *** $p< .001$

that students with prior computer experience of more than 2 years scored significantly higher than students with prior computer experience of 0-3, 3-6 or 6-24 months. Also, students with prior computer experience of 6-24 months scored significantly higher than those with 3-6 months. No significant differences were found between students with experience of 0-3 and 3-6 months, and between 0-3 and 6-24 months.

For total scores, the post hoc test showed that students with prior computer experience of 3-6 months scored significantly lower than students with prior computer experience of 6-24 months or more than 2 years. Students with prior computer experience of more than 2 years also scored significantly higher than those of 0-3 months. No significant differences were observed between students with experience of 0-3 and 3-6 months, 0-3 and 6-24 months, and between 6-24 months and more than 2 years.

Interactions

Results of follow-up analyses for the interaction of gender and computer experience are as following: (a) Male students with 0-3 months computer experiences scored significantly higher than females students who had computer experiences of 0-3 or 3-6 months on confidence and total score. (b) Male students with 0-3 months computer experiences also scored significantly higher on liking than male students with 3-6 months or female students with more than 2 years computer experiences. (c) Male students' who had 6-24 months of computer experiences scored significantly higher than female students with 0-3 or 3-6 months of computer experiences on confidence and total score. (d) Male students who had more than 2 years of computer experiences scored significantly higher than male students with computer experiences of 0-3, 3-6, or 6-24 months and all female students on anxiety, confidence, liking and total score. (e) Female students who had computer experiences of 6-24 months or more than 2 years scored significantly higher than female students with 0-3 or 3-6 months of computer experiences on anxiety, confidence, and total score.

Discussion

The study attempted to examine two related questions: (a) whether college students in Taiwan have positive or negative attitudes toward computers; and (b) whether factors such as different type of college, gender, and prior computer experience will influence college students' attitudes toward computers.

For the first question, the overall attitude score of 25 (63%) to 33 (83%) out of the maximum score of 40 on each subscales, and 76 (63%) to 94%(78%) on total score indicated that, in general, college students in Taiwan had slight to moderate positive attitudes toward computers. The findings were consistent with Clement's (1981) study in which the author reported that students' attitudes toward computer-based courses have been found to be positive among students in junior high schools, high schools, community colleges, and colleges.

For the second question the results of the present study show that , first, college differences in students' attitudes toward computers do not exist in Taiwan. There was no significant difference between students at the management college and the teacher college on attitudes toward computers which indicated that students in different colleges and with divergent academic majors and interests did not develop dissimilar computer anxiety, confidence, and liking. A previous study conducted by Liu, Reed, and Phillips (1992) found that students majoring in math education and science education consistently felt less anxiety toward computers than did those majoring in English education, elementary education, special education, social studies education, and physical education. The findings of the present study, then, appear to be somewhat surprising.

Second, the findings of the study show that there were gender differences in students' attitudes toward computers among college students in Taiwan. The findings total indicate that, in general, male college students in Taiwan had lower anxiety, higher confidence, and more liking

Table 4
Summary of Mean, Standard Deviation, and ANOVA on Computer Experience

	0-3 Months (*N* = 180)		3-6 Months (*N* = 208)		6-12 Months (*N* = 244)		2 Years+^{a} (*N* = 286)		
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*F*
Anxiety	26.34	4.73	26.26	4.16	27.42	4.78	28.02	5.48	7.28***
Confidence	26.26	4.03	25.60	3.41	26.79	4.18	27.60	4.68	9.97***
Liking	27.22	4.13	26.50	3.35	27.28	4.26	26.96	5.32	1.36
Total	79.83	11.29	78.36	9.15	81.49	11.54	82.58	14.02	5.77***

Note.^{a} 2 years+ indicates more than 2 years.
*** $p < .001$

toward computers than female college students. Although previous studies have reported a conflicting result on gender difference in computer attitudes, a study conducted by Collis and Williams (1987) specifically used Chinese students as subjects and found there were few gender differences on computer attitudes among Chinese students. However, the results of the present study are in the opposite direction of their findings. A possible explanation for this is that students in Taiwan are strongly affected by society's reinforcement of sexual stereotypes. Most people in Taiwan view technology/science types of majors in colleges (e.g., electronic engineering, physics, chemistry) as a male domain while literature/art types of majors (e.g., Chinese literature, English literature, and arts) are veiwed as a female domain. Students may be influenced subconsciously by this society's reinforcement of sexual stereotypes while they are choosing their majors in colleges. As a result, a typical phenomenon in a comprehensive university in Taiwan is that more male students enroll in technology/science departments than females. It is the opposite in literature/art departments. This cultural bias may, therefore, result in gender differences in attitudes toward computers when the computer has been viewed as a type of technology.

Third, the results of the present study show that college students in Taiwan with different computer experiences do exhibit divergent attitudes toward computers. The findings indicate that students who have used computers for less than 6 months may have higher computer anxiety than students who have used computers for longer than 6 months. For computer confidence, the results of the study show that students with more than 2 years of computer experiences had significantly higher computer confidence than students with computer experiences of less than two year. Also, students with prior computer experience of 6-24 months scored significantly higher than those with 3-6 months experience. These findings indicate that students who have computer experiences longer than 6 months may develop higher confidence toward using computers. Accordingly, in order to increase college students' attitudes toward computers (i.e., reduce students' anxiety or acquire higher confidence) a teacher in computer education may want to consider extending computer courses for at least 6 months.

Finally, significant interactions between gender and computer experience also suggest some interesting trends in research on computer attitudes. First, male students' attitudes toward computers seemed not to change too much during the first two years of using computers, but when they had more than 2 years of computer experiences, their positive attitudes toward computers increased dramatically. Furthermore, female students seem to increase their positive attitudes toward computers substantially after 6 months of using computers. Moreover, male students seemed to develop more confidence and liking toward computers than female students even in a short period of time of 0-3 months.

Conclusion

As the important role of computers in the information age has been commonly understood, it is reasonable to predict that a student may need to show his/her computer knowledge and skills as an essential ability in order to obtain a job in the future society. To prepare students with this required ability, a college education should provide not only a sufficient technological environment for students but also effective instructional approaches that can ensure students learn necessary computer knowledge and skills. Since previous studies have identified significant relationships between computer attitudes and computer achievement (Dambrot et al., 1985; Marcoulides, 1988; Wiggins, 1984), there is reason to believe that increasing students' positive attitudes toward computers may help students in the learning process. Consequently, the results from this study provide some useful information to teachers and curriculum designers in computer education.

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Math Literacy for Women: A Focus on Gender Issues, Problem-Solving and Technology

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The vision of the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* (1989) focuses on the need for a mathematically literate population in the new technological age. Mathematical literacy in this "Information Age" encompasses the ability to problem-solve, to reason, and to communicate with others and with technology.

Mathematical power for all is a primary goal of the NCTM Curriculum *and Evaluation Standards* (1989); this includes all under-represented groups in our society. One of these groups, females, now makes up a majority of the population, but holds less than 15% of professional jobs which require a college degree and involve mathematics, science, and computers. As education beyond the undergraduate level in mathematics, science and computers is pursued, the number of women represented decreases dramatically. As an example, engineering awarded 15.3% of its bachelors degrees, 13.6% of its masters degrees, and only 8% of its doctoral degrees to women (U.S. Department of Labor, 1990).

The "Women in Mathematics" Project

The "Increasing Roles for Women in Mathematics Project" funded by the Dwight D. Eisenhower Education Program sprang out of a need for increased awareness of and concern about gender issues involved with mathematics and technology in teacher education. In the spring of 1993, twenty teacher participants were chosen to participate in a summer workshop. The teachers were chosen in pairs from various public and private schools within a 60 mile radius of the University of Wisconsin - Stevens Point campus. Teachers were chosen in pairs to provide collegial support and the likelihood of becoming change agents in their schools when they returned with new attitudes, concepts, and methods for teaching. Both male and female teacher-participants were included in the group of teachers; they represented classrooms from grades 3 through 8.

The project personnel included three college teachers and one middle-school teacher with each having expertise in one or more of the following areas: mathematics, mathematics education, technology, and gender issues. The project personnel spent one week planning activities based on two goals: developing an awareness of gender issues that relate to mathematics and teaching and developing higher order thinking skills in mathematics and problem solving using computer technology and manipulatives with female students. During the second week of the project, teacher participants worked with project personnel reading and discussing the literature on gender issues in mathematics, developing activities using the NCTM *Curriculum and Evaluation Standards* (1989), and using Lego Logo for the female students that incorporated higher-order thinking skills by using manipulatives and technology. Time was allotted for teachers to explore and familiarize themselves with the Lego Logo materials and to share ideas related to discussions of gender issues.

During the next two weeks of the project, 44 female students from grades 3 through 8 joined the workshop.

Each day of this 2 week period, the teachers had one hour for preparation and for the sharing and discussion of ideas and projects they planned to implement with their students. During the next 2 hours the girls joined the workshop. The girls were organized in groups of four with two teachers responsible for each group. Teacher-developed activities were used with the girls; the focus was on problem-solving with Lego Logo projects. Emphasis was placed on developing higher-order thinking skills by developing questioning techniques to elicit reasoning processes. "How" and "why" questions became the focus of discussions rather than the traditional mathematics question, "What is the answer?" Following the 2 hour period with students, the teachers and project personnel spent the last hour reflecting on the activities with their students and exchanging ideas and suggestions for improvements and modifications in both projects and student-teacher interactions.

During the final week of the workshop the only female engineer in Stevens Point (a city of 40,000) was invited to speak to the students about her occupation and the academic preparation necessary for her profession. On the day before her presentation, the girls were asked to draw a picture of an engineer. One-half the drawings were of train engineers; the rest were male representatives with only 2 of the 44 girls drawing female engineers. The guest speaker spent a day with the students, describing her role as an engineer, and relating their problem-solving activities to real-life problem solving activities in her profession. From student and parent questionnaire responses, it was shown that this visit by the engineer was a stimulating experience and brought about discussions of engineering as a possible career choice for the students.

Parents were invited to join the workshop at any time. For the last day of the workshop, a special invitation was extended to parents and friends to join our workshop. A large group of visitors came to see the projects their daughters had designed, built, and programmed. The focus was on problems they had solved and activities they had accomplished. Both parents and students were extremely proud of the students' accomplishments.

Causes of the Gender Gap

The main causes of the gender gap in mathematics and computers are subtle and pervasive. The message from many different sources is that mathematics and computers are for boys. The study of mathematics and computers is often seen as having practical value for boys but not for girls. Boys and girls begin their educational careers with similar excitement about mathematics and computers and similar success, but in the grades seven through nine these areas become more frequently classified as male domains (Dossey, Mullis, Lindquist, & Chambers, 1988).

Sex biases happen in the subtle incidents that occur in education. Educators frequently do not believe that gender biases exist in today's classrooms. As one teacher in our workshop stated, "that was true twenty years ago, but not today." This led to a lively discussion led by teacher participants in the workshop, reaffirming the fact that based on their personal experiences, sex biases are still present in educational practices in many ways.

Computers and mathematics have traditionally been seen as a male domain. A computer is a machine, and girls are not socialized to be comfortable with machines. Computers have traditionally been associated with mathematics, and mathematics has not been defined as a female subject. Many females in the past have been discouraged from taking advanced mathematics courses since the perception was that these are not needed for the traditional role of the woman. This was especially true for many mothers of today's female students, and these mothers serve as role models for their daughters.

Parents influence female students' attitudes toward mathematics and computers. Fathers and brothers are more likely to use computers than mothers. Computers and toys that promote higher-order thinking skills are more often purchased by parents for boys than for girls. Boys often build things developing spatial reasoning, whereas girls are more likely to role-play, play with dolls, and play with domestic toys. These gender-based stereotypes help develop societal norms that are different for boys and girls.

Peer groups influence attitudes and expectations for female students. Being interested in mathematics and computers in the middle and high school is "uncool" and people who are interested in mathematics and computers are often classified as "nerds". Females who have been interested in and successful in mathematics will often hide or downplay their interest or ability in mathematics and computers during these years.

Curriculum factors affect attitudes toward mathematics and computers. Girls interpret success in mathematics to hard work not high ability, whereas boys attribute their success in mathematics to high ability. Teachers also make similar assumptions about the reasons for success in mathematics (Fennema, Peterson, Carpenter, & Lubinski, 1990).

In using computers in a group situation, boys often become the active and thoughtful participants; whereas, girls are often relegated to the role of keyboarders. In our workshop, the girls were actively involved in the design, construction, and programming process. Feedback from daily logs of the students indicated that being actively involved in this process was motivating and challenging for them. This involvement would have been lacking in the boy/girl group situation. As one girl stated "without boys you get to do more."

Teacher decisions in the classroom also have been shown to have unconscious, unintentional gender-biased behavior patters. These behaviors include calling on boys for interpretive responses and girls for factual ones and giving behavior and work of boys more attention than that of girls. Boys are encouraged to think divergently and are praised for cognitive tasks, whereas, girls are given procedural tasks and are given answers to questions and solutions to problems rather than help in redirecting their thinking (Leder, 1992).

The media helps create gender biases by portraying mathematics and computer related professions as male domains. Most pictures of scientists, mathematicians, and computer scientists are of males, whereas keyboarders and secretaries are portrayed as females.

Gender biases are subtle, but they are present in all forms of society. There are norms and values for males and females that have endured for centuries and still exist in society today. An awareness of these issues developed through knowledge of classroom practices, parental, and societal influences may be one step in eliminating the subtle messages that negatively affect female choices about careers involving computers and mathematics.

Principles of the Workshop

1. Focus on small interactive groups of female students: Female students work better in cooperative rather than competitive groups (Fennema, 1990). Boys tend to dominate group activities with computers and problem solving. By using small cooperative groups of girls, they become "risk takers" and are able to experiment without fear of ridicule from peers. As one of the female students in our workshop commented in her log, "with boys you might feel uncomfortable, they might think you are wrong."
2. Design problem-solving curriculum and activities around areas that interest girls: In the workshop girls spent one week developing projects that they had created based on their interest. They constructed telephones, a cookie factory, cars, a helicopter, a boat, amusement rides, a baby rocker, and houses with lights and music. They designed, constructed, and programmed their projects using their interests as a starting point. Many students were surprised at the success they achieved, far surpassing their own expectations for themselves. Pride in ownership of ideas and projects was evident in their discussions with parents, teachers, and in their daily logs.
3. Develop questioning techniques that promote problem-solving using higher-order thinking skills: By using a design environment, planning and problem-solving are connected to the constructions of real-life projects that relate to the girl's interests and experiences. Using computer programming to organize thought processes leads to developing processes for problem-solving. By using teacher questioning of student's thought processes, the student is required to verbalize the processes necessary to reach a final goal. This verbalization process enhances the higher-order thinking skills involved in problem solving (Lehrer, Randle, & Sancilio, 1989).

The Project Continues

During the year following the project a club was organized. The club includes the teachers and female students who participated in the summer workshop. This time is designated to discuss with the teachers and female students changes that have occurred in their classrooms which might affect female choices in the areas of mathematics and computers. The club will also be a time for the female students to continue with projects, computer programming, and problem solving with Lego Logo. Parents will be invited to visit the club at various times, since parental interest and support can positively influence female choices in educational planning and careers in the area of mathematics and computers.

Some teachers who participated in the project have become change agents in their local schools. Eighty percent of the schools which participated have instituted some aspect of the workshop in their local schools. One teacher who participated in the program received support from the administration to conduct an in-service program for the teachers in two of the area schools.

Parental support for the program, in the form of individual monetary contribution, was received by school districts involved. Presentations have been made by teacher participants at Parent Teacher Organization (PTO) meetings to get financial support for the technology needed for the project. Support has been pledged by four PTOs to provide financial backing for purchases of the technology. This demonstrates positive parental and community support for the program. Administrators have provided financial support for in-service training and for supplies. Administrators have already seen positive growth in their teacher participants and see them as positive change agents in their mathematics programs.

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Integrating Technology into the Curriculum: Advancing Cultural Diversity

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As we move toward the 21st century one of the most critical factors in education will be how to train teachers to implement technology into the main stream of instruction and provide equal access to a growing diverse population that makes up the majority of students in today's public schools. During the 1980s technology firmly rooted itself in the fabric of education. Ninety-nine percent of all public schools in the United States now use some form of technology. Although the vast majority of schools in the United States have computers, the higher percentage of black students in a school the lower the student-to-computer ratio (Quality Education Data, 1989). In addition, inner-city school districts rarely have the skills or funds to maintain their machines nor the training and social support to use computers effectively (Piller, 1992). As literacy has come to mean more than ability to read and write, a generation of students, the majority who are minorities, are losing their franchise on independence and a shot at the good life in the information age (Hill, 1992). Teachers need substantial training, support, and time to integrate technology into their curricula (International Society for Technology in Education, 1991). Technology in the hands of these well-trained teachers is especially powerful when used with students of diverse backgrounds.

Background

In 1988 the Office of Technology Assessment released a report indicating that states are the key players in the use of technology in education (Miller, 1988). It also revealed that technology cannot be fully effective unless teachers received training and support. Prior to The Nation at Risk Task Force Report, many teachers did not understand how to exploit technology as a teaching tool (United States National Commission on Excellence in Education, 1983). Technology will not transform education to meet the needs of society if teachers do not learn to use it as both an instructional and management tool. The Nation at Risk Report recommended that state agencies support higher educational institutions by assisting them in redesigning their educational programs to include the effective use of technology.

Because the student populations in most public schools are becoming very diverse, the current and future teaching population will have to be equipped with information and tools that reflect a positive relationship with cultural diversity. Using culturally diverse materials in teacher training programs is one way to bridge the gap between students and teachers through the use of technology.

Technology Courses For Pre-Service/In-Service Teachers

In the state of California individuals seeking a permanent teaching credential are required to complete coursework which demonstrates their competence in the use of technology within the classroom. At California State University, San Bernardino, this coursework comprises two courses totaling 6 units of credit. The first course concentrates on access to and control of computer-based technologies through the use of an integrated software package

(ClarisWorks). Students are taught how to use word-processing, spreadsheet, data bases, and mail merge functions as they relate to classroom instruction and management. The second course focuses on the integration of technology into the curriculum.

During the second year of teaching this course it became apparent, through student feedback, that students had limited exposure to and information about diverse populations. Because data bases are especially useful and powerful information tools, I selected them to be the vehicle to introduce culturally diverse information to teachers. The databases presented were a cross section of businesses owned by Blacks and Hispanics. Black and Hispanic businesses were selected because they are one of the most under reported areas in minority accomplishments (Swinton & Handy, 1983). Information was collected on locations, type, chief executive officers (CEOs), number of workers, starting date, and annual sales/assets. The database was limited to companies whose primary business was manufacturing of goods and/or services (Robertson, 1988). A minority-owned business was defined as a business that was 51% controlled by a minority person(s). Professionals including doctors, lawyers, dentists, and others that fell within the definition of professionals were not included.

The content material provided opportunities for students to practice and evaluate various database concepts such as sorting, selecting specific field criteria for analysis, and filtering selected data pertaining to each business database. For example, students were given worksheets containing information about the businesses' starting dates, assets, gross sales, number of employees, types, locations, and gender makeup. They were asked to locate companies based on one, two, and three of these variables to determine regional concentration, most frequent type of business, longevity, and gross assets/sales. They were also asked to determine if there were any patterns in regards to rate of growth. Many students were surprise to find that Blacks owned Saving and Loan Companies before the turn of the century and that the largest concentration of Hispanic businesses in terms of gross sales is located in the Miami area. This kind of information provides teachers with new experiences and strategies to incorporate into existing and/or new curriculum.

Conclusion

With teacher and student populations changing, the importance of fostering culturally diverse material is one critical factor in successfully linking minorities to academic achievement. In the case of my introduction to technology classes at California State University, San Bernardino, teachers realize that business databases provide a different set of role models for students. It is vital that teachers who will be providing instruction for students into the 21st century receive effective training. This training should include recognizing the contributions of persons of diverse backgrounds. Technology for the present and future can surely help to bridge the gap between diverse populations and the dominant culture.

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RESEARCH

The term *research* conjures up a whole range of visions in people's heads. To some it is the equivalent of saying, "this isn't relevant to anything practical or useful." To others it is the same as saying "experimental-control group studies with ANOVA tables." The mix of papers in this section illustrates our working definition of research. It is any reasonably systematic effort to analyze, think about, or reflect upon issues, questions, and problems that are of interest to others. By this definition virtually all the papers in this book would be research. We have pulled together a few of them in this section because they: a) address questions of general interest, and b) approach the questions in a relatively systematic way.

Some of the papers are summaries of professional practice knowledge derived from projects the authors have undertaken. Cawley, for example, offers guidelines for using electronic mail with undergraduate teacher education students while Rheem and Kolloff discuss the integration of hypermedia experiences into teacher education.

Other papers in the research section report studies, primarily surveys, that help us understand current conditions in schools and teacher education programs. Hunt, for example, compared the plans preservice teacher education students had for using technology with actual use in the classroom after graduation. Several studies (Topp, Thompson, and Schmidt; Kraus and colleagues; Nieerhauser and Stoddart; Huang; Sheffield; Nason, and Paprzycki and Vidakovic) assessed the attitudes of preservice or inservice teachers and/or their ability to use technology in the classroom. We now know a great deal more about what teachers think about technology, how much they use it in their classrooms, and how they perceive their ability to use technology. Another study of perceptions, by Wentworth and Connell looked at parental perceptions and made some recomendations about what needs to be done to encourage parents to support innovation in the school. Using networks like Internet and Bitnet to gather survey data was the focus of a paper by Paprzycki, Mitchell, and Duckett.

Several papers in this section also address the question of whether particular approaches are appropriate and effective in different areas of teacher education. Berry, for example, reports on a study of interactive video simulations in a methods course. Bednar, Ryan, and Sweeder looked at the use of video in a preservice program, Galloway studied *Quicktime* multimedia tools, Zimmerman and Blanton evaluated collaborative computer games; and Shaw Nauman, and Burson looked at word processing. Finally, Hillman and Perry's paper outlines a number of the critical questions in our field.

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Technological Competence: Training the Teacher

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This paper narrates the development of a project in the use of electronic mail by undergraduate teacher candidates. The innovation of electronic mail as a means of connecting students and collecting information was first suggested during a project sponsored by the Westchester Education Coalition, whose purpose is to explore ways of improving and implementing change in traditional teacher preparation. Participants were teacher educators concerned with connecting future teachers with technologies for the classroom. The implementation of the project came to fruition in one of the foundation courses (EDU 202, Foundations in Education Theory) in the Teacher Education program at Iona College in Spring, 1993.

The course takes students through important historical and philosophical developments in the growth of education as a discipline. It is designed to help preservice students appreciate the social, historical, philosophical and cultural factors that have combined to create the various understandings of teaching and learning as we know them in this country.

Rationale For Project

There are clear indications that peer support for achievement can be an important contributor to learning (Slavin, 1991). Techniques that resolve the dilemma of humanistic educational goals and the achievement of basic knowledge of content usually involve some form of group work. There is growing acknowledgment of the wisdom that student success in school can be related strongly to the idea of interactive relationships organized around academic work; this is especially true of college students (Light, 1992). The idea of future teachers working together on their learning therefore has an intrinsic appeal that makes even greater sense when combined with technology in the form of computers. This intersection of ideas led to the technological innovation: on-line reports via e-mail.

The E-Mail Project

The e-mail technology was applied to a previous requirement in the EDU 202 course that called for students to report on a site visit to collect information on a program or project at a school. The rationale for the site visit included the concern that these students needed to be engaged on a regular basis with operating schools so as to ground their classroom instruction in real experience. The students had already been placed in schools for a three week observation experience prior to the spring semester and so were usually familiar with the school they selected for the site visit.

The site visit guidelines were distributed and explained along with the additional dimension of sharing the report with classmates by electronic mail. Students were advised that they would be learning how to use the electronic mail system of the college in order to assist them in communicating with the instructor and with each other. Supporting materials for the electronic mail instruction were distributed and students were given opportunities to practice the procedures. The instruction in the use of the system took several class meetings and bears some comment.

Learning the System. Every Iona student is required to complete 3 credits in computing as part of the core curriculum. This requirement means that each of the students in the 202 course has some familiarity with the Iona system and is comfortable in a PC environment. The electronic mail system, however, runs on the mainframe system and needs to be accessed from a lab or by modem. Most students found this to be a significant adjustment even when they had been familiar with the system from other courses. The guidelines for signing on to mainframe computer had to be revised several times as the configurations became better understood by the instructor.

Several classes had to be given over to instruction for signing on and signing off the mainframe, adding a signature, moving from reading mail to sending mail, sending mail to a group, copying mail, and reviewing outgoing messages.

A very significant adjustment surrounded the mainframe text editor. All students were taught the basics of Wordperfect as part of their core course in computing. However, the editor in the mail system was not Wordperfect, but an older version of word processing that differed in several significant ways from WP. It was not a "friendly" package. Students found the lack of a word-wrap feature especially irritating. Many students improved their performance by asking the student at the next terminal for help when needed. Students were comfortable asking for and receiving help from their peers on computers.

Instruction and Public Computer Laboratories. A teacher educator working in this technology will need to be flexible about the amount of time needed to bring the class to independence on the system. The most efficient instruction usually involves having students convene in the computing laboratory. Instructing students in a laboratory setting can be a trying experience for teachers accustomed to a lecture mode of presentation unless certain precautions are anticipated and adjustments made. If an institution has not arranged for separate departments to have exclusive computing laboratories, then public labs must be reserved well in advance through a central authority in the institution. Most faculty would not be familiar with this process unless they had done sufficient investigating. Public labs need to be examined by the instructor ahead of time to be certain that the sign-on procedures designed by the instructor match the sign-on procedures being used in the labs.

Often students throughout the institution are accustomed to working uninterrupted in public labs and are not in the habit of inspecting the reserved time form posted at the entrance to each Lab. The instructor is advised to arrive early at the lab and to announce to the users in the lab that a class will be arriving shortly and would they please make arrangements to end the session they are on and move out of the lab. As a practical matter, this is not a small consideration and should be handled diplomatically so as to be fair to those users who are already in place in the lab.

Learning Curves. Most students found the use of the e-mail system added considerably to the amount of time they needed to spend on campus in order to master the system. They were reluctant to adjust their tight schedules of class, commuting and work responsibilities in order to add the task of mastering e-mail. Additional motivation was provided by the instructor placing on the e-mail system samples of the midterm and final examination questions. Students were advised that the examination material was available in this form only and no hard copies were to be provided. Most students took the extra time to sign on and read the exam questions and take the test. The answer key was placed on the mail facility some time later in order to encourage additional use of the system.

After the basics of e-mail were mastered, the students were directed to send e-mail to the instructor as a basis for a quiz grade. Practice in signing on and signing off the system proved to be a useful part of the instruction. The details of getting in and out of the mainframe system could be confusing when not practiced thoroughly. The sign-on routine eventually became embedded in the ritual of coming to class. Students eventually signed on and signed off automatically with no additional instruction. The next level of expertise proved harder to master.

Students had to learn moving around the e-mail system with its options and its restrictions and its specialized vocabulary. The last item especially can strike the casual user as arcane and confusing. Lessons were designed to teach them separate sections of the system with exercises built in to give them practice in the techniques. As students mastered Send Mail, for example, they would next be asked to Forward Mail and then to Add Nicknames to their Mail Directory and finally, to add a Group to their Mail Directory to receive their reports and research. At this point they were assigned to a Working Group and advised to include the e-mail Address for each member in the Group under their Mail Directory.

Students had paired off for the site visit research. Pairing accomplishes several things. Students are collaborating and both are responsible for the success of the visit. Students are connected with someone they can work with to accomplish a goal and this kind of team work usually results in increased appreciation for the other person. Teachers too often can become isolated, especially in larger schools, and this partnering in preservice education can help them to understand the importance of working together. The instruction makes a point of this aspect of the design. Partners reporting on site visits also divides in half the number of possible reports that need to be evaluated by the instructor.

E-mail allows teams to write and revise on the screen. The reports are submitted electronically to the instructor. Each report is answered electronically by the instructor with additional questions for the team being the usual form of response. Each pair of reporters is also responsible for sending their report to each member of the Working Group. In this way, each of the site visits has a potential audience of 5, (instructor, partner, 3 students in the Working Group) thus increasing the dispersal of information and adding to the consideration of kinds of audience for the writers of the report. No hard copies are exchanged although students are free to print e-mail.

Suggestions for Lab Sessions. Giving instructions while students are seated in front of active terminals can be frustrating. Students will be distracted by the activity on the screen and not readily pay attention to directions being given at the same time. It is good practice to have the terminals dark at the beginning of teaching sessions in the lab in order to assure maximum attention from students to directions that will have a direct bearing on their ability to access the system. Graduate students generally have more difficulty listening to directions than undergraduates in these settings.

Once students are in place and the machines are turned on the instructor may need to have written directions distributed with the steps in the sign-on process arranged so as to minimize the chances for serious problems. The sign-on instructions need to be carefully worked out and pilot-tested with a student or two before the class uses them. Often the directions that appear specific, clear and logical to the instructor will contain ambiguities and gaps in process that will only be apparent when they are followed carefully by a naive user who cannot guess what the instructor really meant to say at a particular point.

As soon as the students are released to work on their own, the instructor needs to be moving around the room watching the screens to see who needs to be helped first. Many times the student will be stuck at a screen and trying to read the entire message while the next student will have gone several screens ahead with no hesitation. The sign-on and mail facility are similar in that several layers of procedures must be gotten through. At one point in order to get from the network to the mail facility screen (most labs at Iona start at the network screen) it was necessary to pass through 8 different screens with at least one keystroke required per screen before a student arrived at the mail facility on the mainframe. The crossing over process becomes routine for students only with practice. Very few students used the mail facility prior to coming to the class; they had all received instruction and practice in the basic computing course but apparently had not made the mail facility a regular part of their schooling processes. Many expressed surprise at the various features of the system and seemed intrigued by the possibilities inherent in this method of communication.

The instructor needs to be prepared to juggle questions from students at varying levels of complexity and usually simultaneously. Once released from having to listen to the instructor for each step, they are free to move at their own pace and so the questions and problems will occur in more or less random order and from various parts of the room. It is often useful to remind them to check with the nearest student first if they have a question. This permits the teacher to spend more time with the truly needy; usually this student has been absent from the previous lab meeting. Often a problem will arise on several screens at the same time and this is usually a sign that the instructions were misinterpreted or badly written. At this point a general direction from the instructor can clarify the issue for everyone simultaneously.

Lab assistants can be very helpful during class sessions when the number of questions suddenly overwhelms the instructor. Lab assistants are most helpful when they have been briefed ahead of time as to the nature of the class and the type of instruction to be provided.

Persistent Troublesome Issues. Very often some students will not be familiar with the keyboard. Even when they have a computer at home or have taken courses on the campus they have not been routinely at work on the system. Students will also find the change of venue upsetting for a while. They are not used to listening to instruction while having such an attractive distraction as a full color monitor directly in front of them. A teacher who is uncomfortable with competition of this kind will need to adjust quickly to the change.

Some students will be very familiar with the computer. These students will often begin to work on the system as soon as they enter the room. They will frequently not hear directions correctly as a result. It is best to have all the machines turned off when students enter so as to have a reasonable chance of keeping their attention for the instruction. It may be helpful to have a more competent student sit near a less competent student to assist him or her when necessary.

Opportunities and Reasons. The students can be encouraged to use the mail facility by several means. Placing examination review questions on the mail system has been mentioned earlier. Students are also assigned to a Working Group usually of 4 or 5 persons for several exercises in class discussion. These groups are responsible for knowing the names of members and eventually they are combined in a mail group by the instructor after inspecting the quiz performances of all and arranging weaker students to be grouped with stronger students. The mail group is assigned a Team Color for inclusion in the Mail Directory for each member. Later, when the time comes for the dispersal of information on site visits and similar ventures, the Working Group receives mail from each member for inspection and review. Ultimately the idea is that each Working Group would be in dialogue around issues generated by the work of the individuals in the group. Hopefully, this particular practice will lead to reflection by these students on the value of collegial problem-solving for education by the educationists. Even in cases where the student is not planning to be a teacher, it is hoped he or she will come to see the value of working together to solve problems.

Implications for Teaching. Electronic mail technology has several advantages in the group setting. First, it is always a typewritten text that is being processed and so the ease of editing can lead to more complex and comprehensive products. Second, the message can be sent and received at any time of day. Students on complicated school/job/commute schedules can be in touch with each other via e-mail in ways not possible with conventional telephone messaging. Third, the instructor can be in communication even when the student is not in class. Messages can be sent and received from various parts of the campus. This instructor can communicate from home by means of a modem and software that allows connection to the mainframe for the cost of a local phone call. Fourth, the duplication of paper and the exchange of papers can be significantly reduced at a savings to several constituencies.

At Iona College, the e-mail project will be continued for several reasons. The students here have first rate facilities to take advantage of. The students going into teaching will be faced with computers in more and more school systems; superintendents will want to employ teachers who are comfortable in such an environment. Students in schools now will, by all accounts, need to be more technologically literate than any previous generation — schools will need teachers who can use the computer with a level of comfort that will make the computer as ubiquitous as chalk and blackboards.

As the semester progressed more and more mail was processed and answered by the instructor. This increase showed across a wide spectrum of students. Several students reported discovering Bitnet which allowed them to write to friends at other universities. Students showed increasing confidence in moving in and out of the system in various labs. Many were at first unaware that the same mail facility was accessible from any lab on campus. They became more comfortable about connecting between classes to check their mail. They needed less and less intervention during lab meetings. They began exploring aspects of the system on their own that were unfamiliar to the instructor but showed promise of being useful and/or interesting once the initial intimidation had worn off. Students seem to grow in confidence to the extent that they realize that they can make mistakes and still make progress. This is a lesson that every student needs.

Communication with students has always been an essential feature of all teaching. Indeed, faculty-student relationships are second only to relationships with peers in the degree to which students are affected by their years in college (Astin, 1992). A teacher who commits to e-mail as a focus for dialogue with students needs to design processes for expediting the volume of electronic text that will begin to flow from those students who take advantage of this opportunity for dialogue. Students who respond to the prompts only because grades are associated with use will only be heard from at teacher-set intervals. However, there will generally be a percentage of students who will eagerly take up the invitation; they will begin to dialogue extensively on the e-mail system with the faculty member. Time management issues become significant dilemmas: wishing to connect means taking time from other responsibilities. Each situation will be full of its own variables. The e-mail assignment is seldom "over" in the traditional sense of that word. Students may continue to stay in dialogue long past the end of the course; the conversation has now gone through the artificial constraints of terms and semesters.

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Integration of Hypermedia into Teacher Education: A Beginning

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As the reform movement continues in education, school systems are purchasing computers and related technologies often without the ability to incorporate them into the curriculum. Schools in Kentucky are mandated by the Kentucky Education Reform Act (KERA) of 1990 to incorporate technology to change the way children are educated in the Commonwealth. The learner outcome on the use of technology from the Kentucky Curriculum Framework states: Students use computers and other electronic technology to gather, organize, manipulate, and express information and ideas. One suggestive use of technology by students involves maintaining at least part of the required portfolios for writing and mathematics in a hypermedia environment. Students may incorporate such aspects as text, graphics, sound, video, and photographs within the entries for their portfolios. However, many classroom teachers are uncomfortable in addressing the learner outcome of using electronic technology because of their lack of knowledge and skills in hypermedia.

Integration of hypermedia

Hypermedia is a powerful tool for teachers to use in creating instructional presentations and packages as well as a vehicle for students to use in expressing information and ideas. While most teachers make personal use of computers, many do not have the background to use computers and related technologies to produce a hypermedia product. Teacher education institutions have been successful with integrating activities such as reviewing and evaluating software packages in teacher education classes but appear slow in integrating authoring programs for hypermedia. Both preservice and inservice teachers need help in first becoming producers, and second, helping students to produce hypermedia products.

To address the need, selected teacher education courses at Eastern Kentucky University have incorporated activities for producing hypermedia products within existing courses. The intention of this paper is to describe issues and activities related to the integration of hypermedia production in the courses. The issues involved in selecting various hypermedia environments included cost, availability, familiarity with platforms, hypermedia literacy, time and effort required for production, and advantages as well as limitations of the hypermedia environments. Three hypermedia authoring systems were selected to be introduced to the students.

StoryWorks

Since the students had little or no prior experience in developing nonlinear products with the computer, the first program selected for use was StoryWorks for MS-DOS produced by Teachers' Idea and Information Exchange. StoryWorks is a low-cost, hypertext software tool for creating branching applications. In addition, a limited number of sounds provided by StoryWorks can be incorporated. This program is available in both MS-DOS and Apple formats. The MS-DOS version selected uses the Microsoft Works word processor to create hypertext stacks.

Using one of the example stacks on Storyworks coupled with the students familiarity with Microsoft Works lessen the startup production time needed.

As an introduction, the concept of developing nonsequential documents through the use of webbing or branching was illustrated. As students started developing hypertext stacks, the need for some type of diagraming or flow-charting of the branching became apparent. Students utilized examples from StoryWorks to gain experience using nonsequential branching. Students were then directed to pick an individual topic within their discipline area for developing their own stack. As preservice and inservice teachers further developed their topics, they became excited about the educational potential for their own students with hypermedia products.

Using the Microsoft Works word processor, StoryWorks segments or cards are created as separate pages. The cards containing related topics or information are linked to each other by transfer directives. These transfer directives define "buttons" or keys on the keyboard which would allow the user of the stack to choose the branching direction. The StoryWorks stack, containing 1 to 1024 cards, is then saved to disk as a standard Microsoft Works word processor file. The StoryWorks program is used to read the stack and activate the transfers and sound effects.

At the conclusion of this hypermedia experience, advantages and limitations of StoryWorks were addressed. Some of the advantages found within this program are the low cost for classroom use and the relative ease of learning to develop stacks. Limitations of the program include the limited graphics capability, limited number of sounds, and the lack of mouse control while running the stacks.

HyperCard

The second hypermedia experience was with HyperCard which allowed students to incorporate text, graphics, and sound into a hypermedia project. HyperCard was selected because of its accessibility on the University campus and to give students experience on the MacIntosh platform. HyperCard is a tool for accessing information by defining one's own way through information, a user-friendly authoring tool for constructing original work, and a gateway to multimedia applications.

Concepts such as branching, stacks, buttons, card/segment introduced in StoryWorks were initially reviewed. Within HyperCard, students were introduced to the concept of an object-oriented authoring program. Students' initial experience consisted of demonstrations of HyperCard stacks and a systematic hands-on activity for constructing a stack. Such hands-on activities are necessary to introduce the concept of "tearing off" the tools menu. Placing the tools menu on the card allows for the selection of tools from the tool palette to browse, work with fields or buttons, and use the paint tools. To keep track of the sequence and branching of information, students often needed to number cards using the tool menu.

Students designed and developed a stack with the five objects: stacks, cards, backgrounds, fields, and buttons. In the development of the stack, students were required to create and incorporate graphic images. Simple HyperCard stacks were based on the students' specific emphasis area (e.g., math, science, music, art, or language arts).

Advantages of HyperCard include the user-friendliness and the graphics capabilities of the program. The accessibility of the tools menu provides for ease when constructing stacks. Limitations for the students included keeping track of various cards, inexperience in using a mouse for constructing graphics, and using the allocated time constructing graphics rather than adding sound effects to the stack.

Multimedia 1

The third hypermedia authoring system used was a shareware package, Multimedia 1 by DareWare, Inc. This package allows students to incorporate text, images, and sound into a hypermedia project on a MS-DOS platform. This program was chosen because of its low cost and its relatively simple computer system requirements (a hard drive and 512 K memory). In addition, the products created can be stored on and played from a single disk.

The students were able to use their previous experience on StoryWorks and HyperCard to begin creating presentations in Multimedia 1. The built-in Development Editor with a pull down menu, mouse support and multiple overlapping windows environment was used to develop a hypermedia program. The program examples and commands, sounds, and images libraries allowed students to develop an initial presentation with relative ease. Students then created projects based on their certification area and level (primary, middle grades or secondary). In their projects, students were required to use images, speech, and sound effects.

Advantages of using Multimedia 1 include the ability to incorporate created, scanned, clip art, or other graphic images in GIF, PCX, PIC, and TIFF files; combine speech, music and sound effects and play them through the PC speaker or sound board; the ease of using the built-in editor to write and create programs; and the ability to create simple or complex presentations. The use of color and special effects is very appealing to students. A limitation with this as with other hypermedia authoring programs is the time to find and develop the graphics and sound files to support a particular selected topic.

Conclusion

These three hypermedia experiences provided the students with practical applications for and experience in using hypermedia. The benefits to the preservice and inservice teachers were in the development of skills in the use of hypermedia and familiarity with both the MS-DOS and MacIntosh hypermedia platforms. Addressing the issues surrounding the use of hypermedia in the classroom was an additional benefit. Students became interested in investigating other hypermedia authoring systems which were available to them in schools, in other computer labs on campus and/or on their home computers. Students compared and evaluated the three hypermedia authoring systems as to cost, availability, platform preference, usefulness in teaching, time and effort required for production, and cognitive effects.

After using the three authoring systems, the use of hypermedia in the K-12 curriculum, especially in relation to KERA, was addressed. Issues raised included the time required to learn a new program, the time needed to create a hypermedia product, the comfort level of the teacher in using hypermedia, the skill level of students, and the often limited availability of computers.

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Intentions and Implementions: The Impact of Technology Coursework in Elementary Classrooms

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The necessity for providing teachers with professional development opportunities in the instructional use of technology is widely recognized. Most states now require that some or all of their teachers gain knowledge and skills for using information technologies. The intent of these regulations is not to prepare "computer literate" teachers, but to positively impact K-12 education by encouraging the effective use of technology in elementary and secondary school classrooms.

This paper will compare the findings of two studies related to the impact of coursework in information technologies for teachers and then consider the instructional implications of disparities found between students' plans for using technology and actual classroom practice.

Participants in both studies were enrolled in coursework required of elementary teachers at a large state university in central California. The first study involved an analysis of reflective "position papers" submitted by 163 of these students upon completion of the course. These papers required students to review the course and determine which topics and teaching strategies modeled in the course they found most valuable and would like to implement in their classrooms. The second study was based upon semi-structured interviews conducted with 35 practicing classroom teachers who had completed the same course in previous semesters. The interviewees were asked about their access to technology, how they applied the course content in their teaching, and how they thought the course might be improved to better meet their classroom needs.

Intentions

One of three open-ended questions asked of students in the position paper assignment was "Which ideas, tools, teaching strategies (if any) are you most anxious to use in your classroom?" As shown in Table 1, students reported being most anxious to use educational software, wordprocessing, and hypermedia technologies.

Numerous subtopics were often noted within these categories. For example, 32 students said they wanted to use wordprocessing for the teaching of writing and another 21 said they wanted to use it for publishing student work. Thirty three reported being anxious to use simulation and problem solving software while 27 wanted to use drill and practice software. Seventeen specified the use of databases to help them organize their student records and 14 wanted to have their students create and use databases for preparing classroom research project. Ten wanted to use Logo to promote the learning of mathematics and development of problem-solving abilities, 6 specified using spreadsheets for classroom organization and record-keeping, 17 said they wanted to teach their students to create hypermedia stacks, and 15 were anxious to use CD-ROM and laserdisc technologies.

Other than mentioning cooperative learning, few students mentioned any specific classroom strategies for managing computer-based instruction. Of those who did, three said they wanted to use computers as "stations" within their classroom and one noted that she would use an LCD panel to project computer images for whole class instruction. Twenty-seven said they would use computers for motivating students, twelve said they would work to integrate computers into their on-going curriculum, and five said they would use computers as a reward or during "free time."

Table 1
Topics students reported being most anxious to use (N = 163)

Topic	# of responses
Educational Software	88
Wordprocessing	81
Hypermedia	61
Cooperative Learning	50
Databases	49
Logo programming	28
Spreadsheets	11
Telecommunications	10

Implementations

In the second study, fifty-one students who had earned their clear multiple subject (elementary teaching) credential between August, 1989 and December, 1992 were reached for telephone interview. Semi-structured interviews were conducted with the 35 who were currently teaching.

Technology Access. Twenty-four of the 35 teachers reported having access to a computer in their classroom, 24 said they had a computer in their home, and 18 said they had a computer both at home and in their classroom. Five teachers reported no access to computer technology for themselves. Twenty-four teachers said their students have access to computers in the classroom, and 26 reported that their students attend classes in a school computer laboratory. Only two teachers reported their students do not have access to a computer. The amount of contact varied greatly, but most teachers reported their students use computers from one-half hour to two hours per week.

Three teachers with classroom computers said their students used the computer for wordprocessing, but most reported their students' computer use consisted of working independently or in pairs on drill and practice software. Several reported they allow their students to use the computer during free time or as a reward alternative. Three teachers who indicated their students had access to a computer lab reported the lab was used with a pre-packaged, commercial (either the Wicat or *Writing to Read*) curriculum.

Coursework Topics. Two interview questions asked which class topics the participants had used or would like to use in their classrooms. As can be seen in Table 2, just over half the participants reported using wordprocessing but since only three teachers reported letting their students use wordprocessing, one might assume that the other 16 teachers have used this application solely for personal productivity. Likewise, since 24 teachers said their students had classroom access to a computer but only 13 reported using their skills in software review, it can be assumed that the teachers use whatever software they "inherited" and have reviewed other packages for use in their classrooms. Less than ten percent reported using computers for any other application.

Table 2:
Classroom Use of Course Topics (N = 35)

Topic	Have Used	Would like to Use
wordprocessing/writing process	19	9
software review	13	0
hypermedia dev/multimedia products	3	9
databases	3	7
spreadsheets	3	6
Logo programming	3	5
cooperative learning/ curriculum integration	2	6
gradebook program	1	2
telecommunications	0	5

Table 2 also shows that the interviewees were interested in using hypermedia and tool software. The teachers were then asked why they were not already using these other applications in their classrooms. Table 3 shows that the most frequently given reasons for not implementing these topics were a lack of equipment or software and limited time in the school day.

Table 3
Factors Which Hinder Use of Course Topics (N = 35)

Hindrances to Usage	No. of Responses
limited access to equipment	13
limited time	8
lack of needed software	4
limited funding	4
teaching in a special education program	2
transient student population	1
student capabilities	1
fear, apprehension over using technology	1
new teacher, other priorities	1
just recently got computers	1
lack of classroom space	1
lack of modem/telephone line	1

Table 3 also reveals some more troubling comments. One person expressed negative feelings about using technology; four implied that computers were not appropriate for their transient or special needs children; and one said that she, as a new teacher, had other priorities.

Suggested Course Modifications. Most students did not offer any suggestions for how the course could be

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modified to better meet their own or future students' needs. There were several, however, who indicated they had had trouble knowing how to start using the computer in their classroom. Six said that they had difficulty implementing what they had learned because they could not visualize how to put into practice the concepts and skills learned in the course.

When asked if there were technology-related topics which would interest them as extension classes, the interviewees had many suggestions. Most frequently mentioned were: the use of CD-ROM and laser discs, software review, telecommunications training, desktop publishing, classroom management, and hypermedia authoring. The reader might note that these same topics were the ones mentioned by those completing the basic technology course and by the interviewees when they were asked what they would like to be using in their classrooms.

Discussion

Most of the teachers interviewed have access to computer hardware at school, at home, or both. However, most are relying on their computers solely for wordprocessing and/or drill and practice games. This corroborates the findings of a similar study (Keirns, 1992) in which seven practicing classroom teachers who had taken an equivalent course at another California State University campus were interviewed. Keirns found that these teachers had expanded their repertoire of computing skills as a result of the class, but the range of their computer use was still limited to rather mundane tasks and only two reported changing their instruction to include more computer-based activities.

As was true of the educators described in the landmark government study reported in *Power On! New Tools for Teaching and Learning* (OTA, 1988) most of the teachers in this study cited a lack of money, hardware, software, and time as the factors limiting their instructional computing usage. Further probing revealed that time was the most critical factor — time to explore the school's resources, time to review and order software, time to learn new software and envision its use, time to set up equipment, and time to include computer-based activities in the school day. It could even be said that time was a critical factor in their ability to lobby administrators and parents to fund hardware and software purchases specifically suited to meet their students' needs.

The interviewee who expressed apprehension about using computers in his classroom had been a student in one of the author's classes five years ago. He was clearly fearful of the computers at the beginning of the class, but became more comfortable over the period of the semester and, indeed, thanked the author for her patience and support as he became a technology user. Unfortunately, there was a four-year period between the time he had taken the course and the time he began teaching. He had not continued practicing his skills during this period, so had lost them. He was upset with himself for letting this happen and requested (and was given) permission to sit in on the class again long enough to re-learn wordprocessing.

Surely those teachers who explained their lack of computer use on the type of student they teach are working from a lack of awareness. Non-remedial computer-based instruction has been shown to be highly motivating for at risk and special needs children (Martinez & Robbins, 1992) and many excellent products for English as a Second Language learners have recently come to market (Hunt, 1993).

In reference to the teacher who said she had other priorities, if she had internalized the value of computers for accomplishing instructional and classroom management tasks, she would view them as a godsend for any teacher, new or veteran.

Implications

We know that the inclusion of educational technology coursework in teacher preparation programs is having an impact in K-12 classrooms. Anecdotal records of students returning to campus and reporting proudly about how they are incorporating computers in their instruction; informal interviews with school district personnel who report that the new teachers coming in are clamoring for computers and software, questioning administrators regarding their spending priorities, and becoming involved in school-wide technology planning tell us that we are having such an impact.

However, we can also see that the impact of this coursework has not been as widespread and deeply embedded into instruction as we might like. The studies discussed here show that elementary school student computer use is mostly limited to wordprocessing and drill and practice software and their teachers' use of computers is typically limited to the clerical chores of teaching.

Given the complexity of the task, it is not reasonable to expect teacher preparation programs to be solely responsible for instructional innovations in K-12 education. But clearly teacher preparation coursework in educational technology can be enhanced by listening to graduates and heeding their concerns. To increase the depth and breadth of K-12 classroom implementation, it is suggested that teacher education faculty consider modifying their coursework to include:

- discussion of classroom management issues,
- visitation of model K-12 classrooms (or experiences with videotapes and hypermedia resources portraying such classrooms) in which students can see computers being used for more than drill and practice sessions,
- demonstrations of software and instructional methods appropriate for working with special needs children, and
- activities in which students envision themselves using technology as a medium for instruction and seek administrator and financial support for their efforts.

I also believe that seeing technology used in a single course in educational computing, or even within several university courses, is not sufficient for preparing teachers to effectively use information technologies. Students must have many models of effective technology use, and they typically did not see advanced technologies used in their own K-12 education or in their postsecondary experience. The sites selected for preservice field experiences must give students multiple opportunities to observe and practice teaching with technology during their student teaching assignments. It is in these preservice field placements that students become acquainted with the realities of life in elementary and secondary classrooms, look for real-world connections to content presented in their university foundations and teaching methods classes, and develop their own instructional and managerial skills.

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Student Teachers' Perceptions of Technology in the Schools

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For almost 20 years, integration of technology in the classroom has been a focal point for innovation in our nation's educational system. Two issues have dominated the discussion: the potential of the new technology and the need to effectively "integrate [the technology] throughout their curriculum" (Baron & Orwig, 1993, p. 5). Research on such varying aspects of technology in the schools as attitudes, anxiety, and performance has proliferated as educators attempt to make sound decisions about computer use (Richards, Johnson, & Johnson, 1986). One aspect of the integration of technology which has been studied is the training required for effective use of instructional technology. As in other content areas, the type and amount of training in instructional technology available to teachers varies enormously in quantity and quality. Like other educational innovations, the integration of technology has become an important issue in preservice teacher education programs.

Review of Current Literature

Current research literature on student teachers' attitudes toward the integration of technology in the classroom supports the importance of experiences with technology prior to student teaching. Such pre-student teaching technology experiences appear to have a positive effect on both skills and feelings of preparedness for integrating technology in the classroom.

In a study of student teachers' perceptions of instructional technology, Hunt and Bohlin (1991) found that the majority of student teachers who reported prior computer experiences indicated their experiences consisted of word processing or recreational uses like computer games. Such previous computer experiences were strongly correlated with positive student teacher attitudes toward the use of computers in their future classrooms. Unfortunately, these student teachers were generally unable to identify ways teachers might use computers in their work.

Another study (Dradowski, 1993) which investigated a preservice computer education program by describing the attitudes of three students in the process of completing the program focused on the respondents' views of their completed training. The participants' responses supported the idea that the computer education base focusing on technical aspects of instructional technology was too narrow and should grow from teaching students about computers to teaching future teachers on how to teach with computers. The findings also indicated that the students must pass through stages or levels before adapting an innovation. Prior experiences are an important element in progressing through these stages when attempting to become competent at integrating technology into the classroom.

Brownell, Zirkler, and Brownell (1991) looked at the perceptions of preservice teachers and measured their attitudes toward teachers as computer users. They reported that preservice teachers viewed the computer user as "more strongly gaining efficiency" through the use of a computer. This is to say that they felt other professions gained efficiency at the job site more from using computers than did teachers. The study also indicated that increased use of computers during their college years could lead to a better understanding of how to use technology in the classroom.

Handler (1993) studied first-year teachers' sense of preparedness to use instructional technology. She found that first-year teachers who reported that instructional technology had been integrated in their methods courses or in their student teaching felt better prepared to integrate computers into classrooms than their peers who had not had such integrated experiences. She also reported that, while taking a single technology-oriented course helped improve the preparedness of those who had little prior technology experience, the modeling of instructional technology integration in courses and student teaching was crucial to feelings of preparedness. Through a qualitative component of her study, Handler found that first-year teachers perceived four main gaps in the use of technology in their preservice training:

> (1) the need for additional information about hardware,
> (2) the need for additional information about and experiences with software,
> (3) areas in which the teachers felt they needed to become more comfortable with computers, and
> (4) their needs as new teachers to have had opportunities to become more familiar with instructional strategies for using computers for instruction. (p.151)

Since student teaching experiences play a pivotal role in teacher education (Guyton & McIntyre, 1990), it seems wise to specifically examine the role of such experiences on knowledge of and attitudes toward instructional technology. The impact of student teaching experiences becomes especially important when teacher education programs do not have access to current technology available in public schools or lack the facilities to thoroughly prepare large numbers of prospective teachers in technology.

Purpose and Design of the Study

This study used qualitative research methodology to examine the impact of experiences with technology prior to and during student teaching on students teachers' attitudes toward and knowledge of the use of instructional technology. The 11 secondary student teachers who participated in the study were assigned to a public senior high school which emphasized the integration of technology in classroom instruction. Student teachers were expected to design and deliver instruction using instructional technology. All the student teachers received on-site training in the use of instructional hardware and software available at the school including Edlan products, multimedia, and Ultimedia. The training, provided at the start of student teaching, was conducted by the teacher who was responsible for training the school faculty and facilitating technology integration. After approximately six hours of orientation to available technology, each student teacher was encouraged to identify the technology most appropriate for his/her content area. Training in that technology was then provided. In some cases the training could be completed in a few sessions. In other cases (i.e., Linkway) the training continued for most of the semester.

The 11 student teachers represented a variety of secondary content areas with two in English, four in mathematics, and five in social studies. Four student teachers assigned to the school in the 1993 spring semester responded in writing to a series of questions. The questions addressed prior experiences with technology, technology training and use in student teaching, expectations for future use of technology, and perceptions of the value of instructional technology. Seven student teachers assigned to the school in the 1993 fall semester were interviewed using a semi-structured interview schedule. Interview questions addressed prior experiences with technology, perceived value of instructional technology, technology training and use in student teaching, and expectations for future use of instructional technology. The data were gathered early in the student teaching experience. At that point, student teachers understood that integration of technology was expected but had not yet participated in on-site technology training.

Results

Data from the questionnaires and transcribed interviews were segmented into idea units and categorized using a phenomonological approach (Hycner,1985). The categories identified through our analysis were (1) knowledge of instructional technology, (2) prior experiences with technology, and (3) attitudes toward and perceptions of the role of instructional technology in the classroom.

Prior experiences with technology

The prior experiences reported by the 11 student teachers varied widely. Six of the student teachers reported that the eight-hour microcomputer module required for entry to the teacher education program was their only experience with instructional technology. At the other end of the spectrum, one student teacher reported experience in two computer programming languages, word processing, and using computers in university content area courses. Despite the differences in prior experiences with technology, the descriptors the student teachers applied to their level of experience were remarkably similar, "pretty minimal," "I haven't had much," "not much," "I did not get much," "very little, if any," "I'd say little, if any," and "very little." Only two student teachers did not characterize their level of experience in a negative way.

Knowledge of instructional technology

Analysis of student teachers' knowledge of technology revealed relatively low levels of the technological knowledge as well as some interesting perceptions of technology's potential role in education. Student teachers' access to and experiences with instructional technology were limited. All of the student teachers had completed the required microcomputer module. Two of the student teachers had also seen some laser disc technology at the university, all the math student teachers had seen graphing calculators, and most of the group reported word processing papers for classes. One student teacher was aware that Linkway existed because her roommate had used it while student teaching at the same high school. All the student teachers indicated they had access to computers at university microcomputer labs and at the high school. About half of them also indicated they had access to computers or word processors owned by roommates or friends. Three of the student teachers reported owning word processors, and one indicated she had a personal computer. None of the student teachers, however, was able to articulate specific goals, guidelines, or principles related to the use of instructional technology

Attitudes toward instructional technology

Two student teachers' interviews consistently supported their stated comfort in using and learning to use instructional technology. Three other student teachers indicated that they were "unsure" but had already begun to select the technology they hoped to implement. Another group of three student teachers characterized themselves as neutral. Of this group, one student teacher's attitude actually seemed consistently neutral. She indicated that she knew technology integration was required and thought that was helpful to the kids but she portrayed no emotion about the expectation or the technology. She seemed to see this as a task which was neither objectionable nor desirable; it was simply a fact of life. The other two students who said they were neutral expressed considerable ambivalence about the "difficulty" of implementing technology. A final group of three student teachers were unequivocally apprehensive. These student teachers expressed concern about student response, breakdown of equipment, and the difficulty of learning to use technology.

Perceptions of the role of instructional technology in the classroom

Student teachers' perceptions of instructional technology's potential role in their classrooms were rather limited and seemed to reflect four basic themes: technology as managerial support, technology as a motivational tool, technology as an unreliable or difficult requirement for teachers, and technology as an unknown.

Three student teachers seemed to perceive instructional technology as a managerial support. Two of these student teacher reported that technology was useful for making tests or worksheets. As one of them said, "you have a nicer end product" that "looks better to them [students]." Two of the three student teachers in this group also indicated that their goal for implementing technology was to "maybe" have their students "do papers" on the computer.

Three student teachers seemed to view technology as a teaching tool. One, who had seen his cooperating teacher use Ultimedia, seemed to see instructional technology as a motivational tool that "kids are interested in," "is lifelike," and "covers pretty much everything in history." A second student teacher noted that the school had 90-minute periods and that meant using a variety of resources, including technology, to keep students' interest. The third student teacher, who responded similarly, noted that "different people learn in different ways and I have to cover all of them." He felt technology could help him do that.

A third theme depicted technology as an unreliable or difficult requirement for teachers. This theme was very common; nine student teachers indicated in some way that implementing instructional technology was "scary" or "difficult" or "great, but you can't rely on it." Perhaps the ambivalence these student teachers felt about instructional technology is best captured by the student teacher who expressed a concern that students might not respond well to instructional technology and then went on to say, "Computers sometimes scare me. If it is easy... and I see something that would really work..., I will be more than happy to work with it as much as I can but it will be difficult for me." Another student teacher indicated that technology is a "great aid" that "breaks up monotony" but he cautioned that teachers "should not depend on it or rely on it. Some people get too wrapped up in it." Interestingly, the student teacher who spoke of the value of technology in accommodating students' learning styles also reported feeling "neutral about it because change is not always good and some children do not always learn by that method."

The final theme came from student teachers who really felt that instructional technology was an unknown for them. While all the student teachers were somewhat unsure of themselves in implementing instructional technology, the five student teachers for whom this theme predominated were unable to articulate any specific ways instructional technology might be used. Not surprisingly, they reported feeling "scared," "apprehensive," "curious," and "unsure" about the requirement that they implement technology in their student teaching.

Conclusion

Earlier studies have established the importance of prior experiences, integration, and focus in preparing teachers to implement instructional technology. However, the reality is that prospective teachers still do not seem to have adequate preparation to effectively implement instructional technology. While experiences with technology seem to be more available than in previous years, it cannot be assumed that all prospective teachers have had such experiences. Many of the students in this study report very minimal experiences with technology prior to student teaching. No matter what experiences these students have during student teaching they have been deprived of the opportunity to move slowly through the levels of adopting an innovation which Dradowski (1993) found to be so important.

The student teachers' attitudes toward instructional technology varied widely. Fear of the unknown appeared to be a prominent and natural contributor to their attitudes. Since their experience levels were so diverse, the variance in attitude reflects the findings of Hunt and Bohlin (1991). It is interesting to note that, unlike the student teachers in Hunt and Bohlin's study, none of these student teachers reported any recreational use of computers.

It appears that a lack of focus on and integration of instructional technology in the teacher education program allowed the student teachers to form their own misconceptions of technology. The respondents' inability to present specific goals, guidelines, or principles related to the use of instructional technology indicates a need to integrate technology in both content area and methods courses at the university. The student teachers had not been systematically exposed to or given instruction in the use of technology during coursework prior to student teaching. In short, these student teachers were experiencing every "technology use gap" described by Handler's (1993) first-year teachers.

The themes and ideas that emerged from the students teachers' perceptions of the role of instructional technology in the classroom were as varied as their attitudes. The four themes which emerged demonstrated that the student teachers did not see instructional technology as a classroom learning tool. Again, earlier experiences might be designed to alleviate this problem; however, another effective approach of preparing future teachers may be site-based technology training during student teaching.

Three main premises support the effectiveness of a site-based approach to instructional technology training. First, every school has a specific set of available technology. If site-based training is used, student teachers will be able to select appropriate and available technology and actually implement it in their teaching. Second, the relatively small number of student teachers assigned to any one school would allow for much more personalized instruction. Such personalization may be important in alleviating anxiety and creating a sense that instructional technology is an effective and valuable learning tool. Finally, site-based instruction allows the student teacher to integrate technology in an authentic setting. There is a strong and well-documented tendency for novice teachers to see field experience learnings as more practical and valuable than university learning which they tend to characterize as ivory tower and theoretical. Site-based training in the use of instructional technology may promote the adoption of instructional technology as a valuable and practical part of the teaching repertoire.

This study suggests that teacher educators must continue to carefully examine the effects of their programs on prospective teachers' understandings of and attitudes toward instructional technology. The implementation of isolated experiences, however well designed, does not adequately prepare student teachers to implement instructional technology. In a follow-up study which examines the impact of site-based training in the use of instructional technology, preliminary analysis of the data suggests that site-based training has had an enormous impact on student teachers' attitudes toward and understandings of instructional technology. Partnerships between public schools and teacher preparation programs may be a powerful method for preparing student teachers to effectively implement instructional technology as they begin their teaching careers.

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Teacher Preservice Experiences and Classroom Computer Use of Recent College Graduates

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Computers and computer-related technologies have become an emphasis in many American schools over the last fifteen years. The number of computers in schools have increased dramatically, with the current estimation being over two million total computers in K-12 schools nationwide (Bork, 1991). Not only have the numbers of computers increased in schools, but also increased is the attention given to the need for computers to be used by educators at all levels.

Given the increased emphasis on using computer-related technology in classrooms, some teacher preservice programs have tried to provide preservice experiences to help future teachers use computers effectively in their instruction (Niemiec and Walberg, 1987). But, often, the teacher preparation programs have been criticized for reacting to what is already happening in K-12 schools instead of leading (George, 1991). To address this issue, twelve goals for educational computing and technology preparation in teacher education programs were written jointly by the International Society for Technology (ISTE) and the National Council for Accreditation of Teacher Education (NCATE) (Wetzel, 1992, p. 148). These goals emphasized that future teachers should be able to demonstrate knowledge about computers and the effective use of computers in classrooms.

The literature dealing with preservice teacher education programs and the emphasis on computer-related technologies can be categorized into three themes. These include the rationale for including computer-related technologies in the programs, the use of computer-specific courses, and the integration of computer-related technologies into all or most education courses.

The rationale for making changes that include computer-related technologies has several bases. With the increasing number of computers in schools, school districts expect teachers, especially new teachers, to be familiar with the technology and be able to use computer-related technologies effectively in their classrooms (Carlson, 1991; Johnson and Maddux, 1991; Novak and Berger, 1991a). Not only do school districts demand computer literate teachers, but also at least 23 state boards of education have requirements dealing with computer experiences in teacher preservice programs.

In most teacher education institutions, the first attempt at preparing their future teacher students to use computer-related technologies has been computer-specific courses. These courses, often introductory in nature, usually emphasized computer skills (Strudler, 1991). Some topics included in these courses were learning to use computers, memorizing terminology, learning to construct computer assisted lessons, and evaluating software and hardware.

Although the computer-specific courses provided an introduction to computer use in classrooms, many authors believed the key to providing quality computer experiences was to incorporate computer-related technologies into all or most education courses. The modeling of teaching strategies that utilize the power of computers by college instructors has been the emphasis in many institutions (Harringtton, 1991; Nelson, Andri, and Keefe, 1991; Novak and Berger, 1991a; Strudler, 1991).

Purpose and Methodology

The purpose of this study was to investigate teachers who are recent college graduates. The main emphases was: 1) computer use by the teachers, and 2) teachers' evaluation of their preservice preparation for using computer-related technologies. Data were collected from results of a survey that was completed by 135 Iowa teachers who had graduated from Iowa State University during the years of 1986 through 1990.

It should be noted that Iowa State University has incorporated computer technology in its teacher education program since 1983. A computer-specific course has been available for education majors for almost a decade and about one half of the education majors elect to participate in this computer-specific course.

The Survey Instrument

The research team designed survey, "Survey of K-12 Computer-Related Technology Use by Iowa State Graduates," included four sections. Section one contained general information questions about the respondent, such as gender, age, general computer use and teaching experiences. Information about the respondents' preservice experience, such as number of completed computer-specific courses and year of graduation, was also included in this section. The respondents were asked to rate the importance of a computer-specific course in teacher preservice programs and to choose the most important topic of such a computer-specific course.

Section two contained three parts. In parts I and II, the respondents were asked to use a Likert-type scale to answer questions on their proficiency in using various computer-related technologies and their interest in using computers in their classrooms. In part III the respondents reported the frequency that they used certain computer-related technologies during the past school year.

The third section of the survey dealt with teacher attitudes toward computers and computer-related technologies. The survey included items on attitudes about personal as well as classroom use of computers.

In section four, respondents evaluated their preservice preparation program in the area of educational computer-related technologies. This was done both in a numeric, Likert type response, and also in an open-ended format.

Results and Discussion

Most responding teachers (97.8%) had used a computer at some point in their life. Over 85% of the teachers reported that they used the computer in their teaching and about 44% owned a computer for their home. Computers were available daily in their school to about 87% of the respondents, but a liquid crystal display (LCD) panel was available to only 25% of the teachers.

Teachers' Use of Computers and Attitude Toward Computers

Items on the survey dealing with teacher computer use was divided into three sections. They were teachers' *proficiency* in using computer-related technology, teachers' *interest* in using computers, and teachers' *frequency* of using computers.

Teachers' average response to their *proficiency* in using computer-based instructional applications (e.g. drill and practice, tutorials, educational games, problem solving/higher order thinking, simulations) was 3.64 (between low[3] and medium[4]), with the highest being 4.04 for educational games. Their proficiency in using computer tool software applications (e.g. word processing, databases, spreadsheets, desktop publishing, graphic/drawing programs) averaged 3.44, with the highest being 4.40 for word processing. In the newer, emerging technologies of this category, the highest was 2.40 for videodisk usage.

The responding teachers rated their *interest* in using specific computer applications in their classrooms or computer labs. The overall mean of this section was 3.49 (between low and medium), which was much higher than the mean of the proficiency section (2.86, between none and low). The application with the highest interest rating was word processing (4.44, between medium and high) followed by problem solving/higher order thinking skills (4.30).

Respondents also reported their *frequency* of using different types of computer-related application. The most often used computer application was drill and practice with an average rating of 2.64, followed by word processing, with an average rating of 2.39. These mean scores indicated teachers use these types of computer-related technologies between sometimes (1-4 times per year) and often (5-10 times per year). Videodisks, CD-ROM, hypermedia, and telecommunications were seldom used. Their average scores were between 1.06 and 1.27, indicating between never and seldom (1-4 times per year). These results paralleled many national teacher surveys completed over the past eight years (Becker, 1990; Office of Technology Assessment, 1988; Sheingold and Hadley, 1990). As the results indicate, these newer teachers were not using the newer applications of computer-related technologies to a great extent, even though almost one-half of them had been introduced to the applications in college. The reasons for this are unclear, but the lack of equipment, as indicated by the low number of LCD panels available, may be one of the large barriers to the use of these newer, emerging types of technology.

In the attitude section of the survey, three factors emerged from the 23 teacher attitude items. The mean responses for the factor, teacher confidence toward using computer-related technologies, was 3.93 (close to agree). The mean response for the factor, teacher general attitude toward computer-related technologies, was 4.30 (between agree and strongly agree). The mean response for the factor, teacher attitude toward the necessity of computer-related technologies in education was 4.55.

The results of this study dealing with teacher computer use and attitude indicated that teachers had a very positive attitude toward computer-related technologies. They believed strongly that using the computer is a necessity in education, and they seemed somewhat interested in using various types of computer applications in their teaching. Yet, with many of the newer, emerging types of computer applications, they did not feel proficient in the use of the computer. In addition, they actually used the computer infrequently, especially with regard to the newer uses that have much potential for improved student learning, such as hypermedia, video disk, and telecommunications (Dede, 1987; Maddux, 1993). The reasons behind this finding are unclear. Lack of equipment and lack of proficiency would seem to be two logical barriers to frequent use of the technologies. Also, another possible reason for this phenomenon could be the lack of preparation in their teacher preservice experiences (this will be discussed later in this paper).

Teacher Preservice Experiences

The respondents' teacher preservice experiences were varied. About 43% of the total respondents completed the computer-specific course, "Educational Applications of Computers". Almost one-half (45%) of the respondents indicated they completed no computer-specific courses in college and about 30% completed one course. About 25% of the teachers completed two or more computer courses during their preservice education.

These figures are noteworthy for two reasons. First, several state boards of education (not Iowa) have required such a class be included in teacher preservice programs. Second, when the respondents were asked to rate the importance of a computer-specific course in teacher preservice program, over two thirds selected "very important and should be a requirement". "Very important" was selected by 26.7%, with less than 6% selecting "no opinion" or "not important" (See Figure 1).

It should be noted that the computer-specific course has fallen out of favor with many authors (Novak and Berger, 1991a; Strudler, 1991). These authors suggested the infusion of technology in all teacher preservice classes should be the direction of most teacher education programs, not the computer-specific course. The responding teachers in this study seemed to disagree. They viewed the computer-specific course as very important. The reasons for this view are unknown. One possible reason may be that although the teachers were interested in using technology, they were not actually using it themselves to a large extent, and, with this finding in mind, they may have seen the computer-specific course as the only solution to computer competency. Since they were not modeling technology use in their classrooms to a great extent, they may not have thought about modeling in college courses as the best possible situation for learning about the use of computer-related technology in classrooms.

The recent graduates were asked what should be the main focus of an undergraduate computer-specific course. Almost 40% believed the development of strategies used to

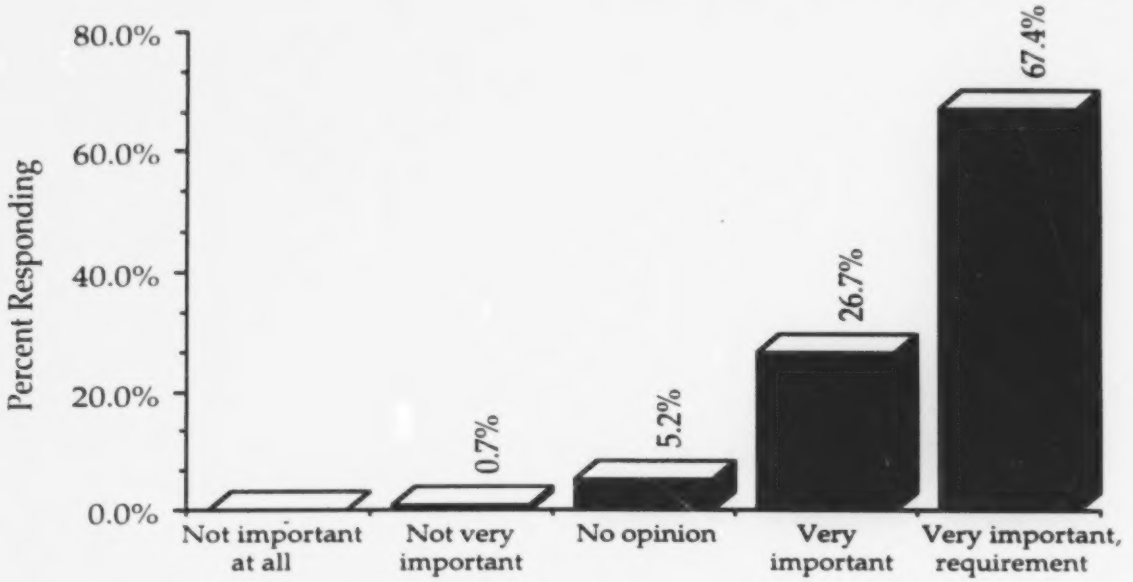

Figure 1. Respondents' ratings about the importance of a computer-specific course in teacher preservice programs.

integrate computers into all disciplines, was most important. Using tool software (which is often useful in many different disciplines) was the second most chosen response (28%). Only 17% indicated that learning to use the computer should be the main focus of such a course. It is noteworthy that these teachers have the same basic priority for a computer-specific course as many authors do for computer-related technologies in general (Maddux, 1993: Sheingold, Martin, and Endreweit, 1987; Vockell and Schwartz, 1992).

When asked how many of their educational methods courses included modeling of computer-related technology by the instructor, 53% of the respondents indicated zero, 30% indicated one, and 11% indicated two. The results of this item are of concern. Much of the current literature dealing with computer-related technologies in teacher education emphasize the importance of instructor modeling in educational methods courses. (Gunn, 1992; Johnson and Harlow, 1993; Novak and Berger, 1991a; Strudler, 1991).

The respondents, recent Iowa State University graduates, were also asked to rate their preservice preparation in using computer-related technologies. About two thirds (67.4%) of the total number of respondents selected either "very inadequate"(27.4%) or "inadequate" (40%) (See Figure 2). Comparing these figures to a nation-wide survey of students teachers by Fratianni, Decker, and Korver-Baum (1990), the Iowa State graduates were somewhat more satisfied with their preservice preparation. About 81% of the student teachers in the Fratianni et al. study, compared to 67.4% of the teachers in this study, felt that their undergraduate preparation in technology use was inadequate.

It should be noted that the teachers who had not taken the computer-specific introductory course, SecEd 101, reported a much lower rating for their preparation, than those respondents who had completed such a course. In fact, over 85% of the "non-SecEd 101" respondents rated their preparation in technology as either very inadequate or inadequate, compared to a 30% figure for the respondents who had completed SecEd 101 (See Figure 3). This would seem to indicate that SecEd 101 may have given teacher preservice students opportunities that they felt helped them prepare for computer use in their teaching.

Recommendations

The following section of this paper will include recommendations dealing with the preparation of future teachers to use computer-related technologies in their classrooms. Teacher education institutions need to be continually modifying their programs to meet the needs of a rapidly changing school environment.

Recommendation One:

Colleges of education need to provide, possibly even require, at least one introductory computer-specific course. Although most authors emphasized the need to move past such a course, this research indicated that teachers believe this type of course is very important.

As indicated by the teachers' responses, the main goal of this course should be the learning of strategies for integrating computers into all disciplines. In order to achieve this

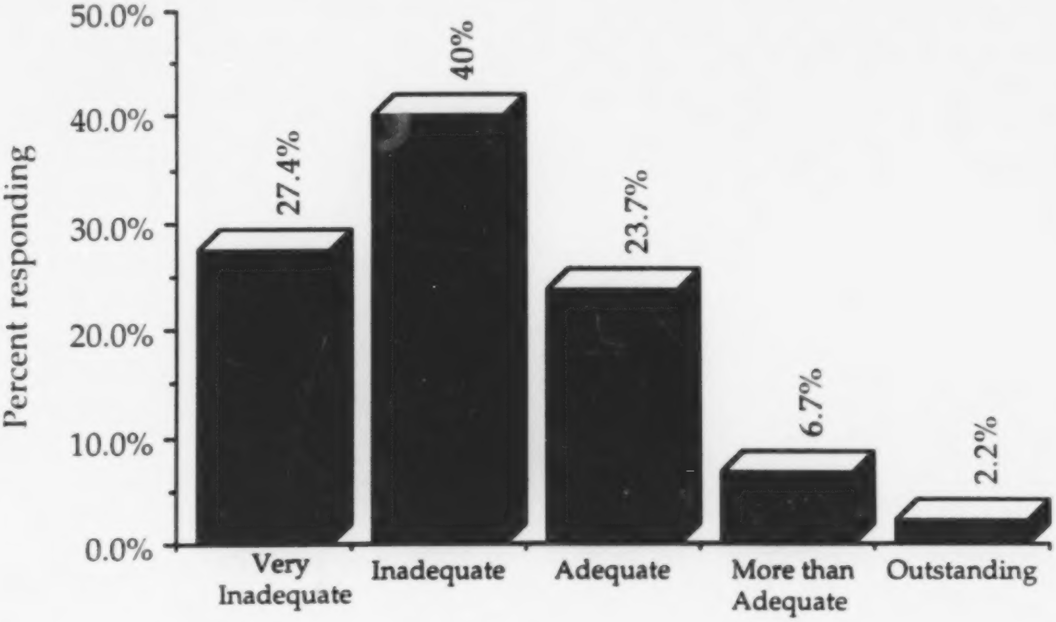

Figure 2. Respondents' evaluation of their preparation for using educational computer-related technologies.

goal, the course should be designed to address as many of the ISTE/NCATE standards as possible. Personal computer proficiency (standards 1, 9, 11, and 12) should be one objective of the course. Another goal should be introduction to using the computer in teaching/learning (standards 2, 3, 4, 5, 6, 7, and 8).

Recommendation Two:

College instructors must model teaching and learning strategies that include computer-related technologies in all their courses (Harrington, 1991; Johnson and Harlow, 1993; Novak and Berger, 1991a; Strudler, 1991). It must be understood that a computer-specific course, as described above, is not the extent of technology in a teacher education program. It is just the beginning, a sort of foundation, for the preparation of future teachers to use computer-related technologies effectively in their classrooms. Preservice teachers need to experience learning while using computer-related technologies in all courses.

Conclusion

This study, based on a survey of recent graduates of Iowa State University who are teachers in Iowa, examined teachers' computer use and attitude toward computers, as well as their preservice experiences. The respondents computer use and their attitude toward computer-related technology was very similar to many national surveys. They were somewhat interested in using technology, but they rate their proficiency low. Although the teachers indicated that computer-related technologies are important to K-12 education, they reported they used computers infrequently.

In regards to teacher preservice programs, most of the teachers believed the computer-specific course was important, with many suggesting such a course should be required. In addition, when asked to rate their teacher preservice preparation for using computer-related technologies in their classrooms, many felt they were inadequately

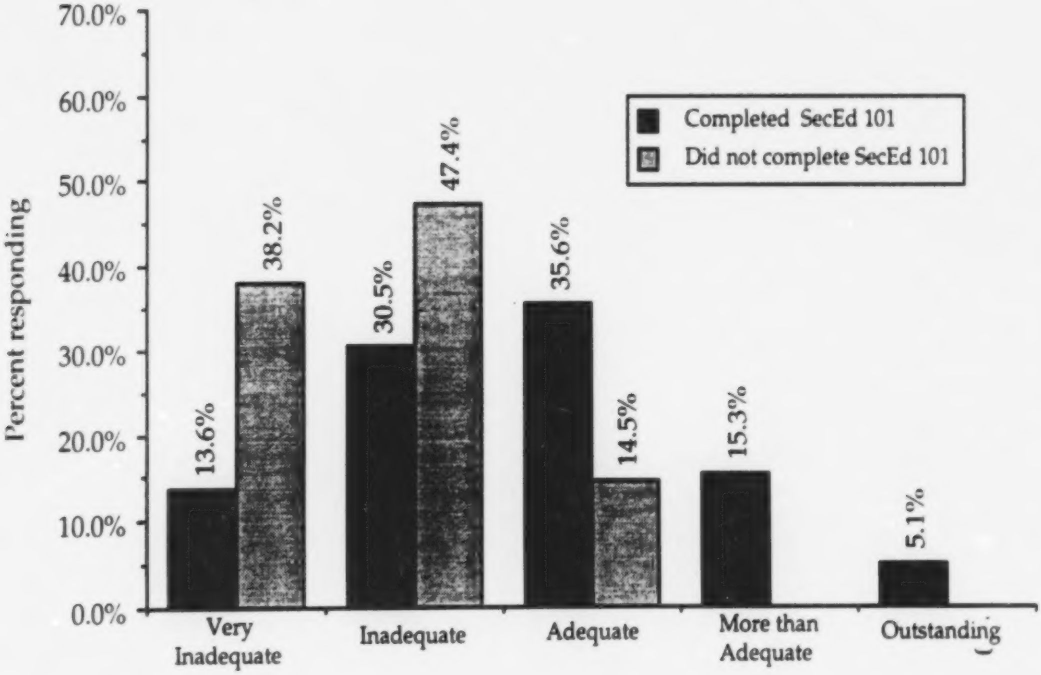

Figure 3. Respondents' evaluation of their preparation for using educational computer-related technologies comparing those who completed SecEd 101 and those who did not complete SecEd 101.

prepared. These findings seem to indicate teacher preservice institutions need to carefully examine their programs. K-12 students deserve teachers who are able to use computer-related technologies in ways that will facilitate and encourage learning. With this in mind, all teacher education graduates need to have had experiences that will help them develop strategies for using computer-related technologies in their own classrooms.

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The Relationship Between Teachers' Beliefs about Computer Assisted-Instruction and Their Practice

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The current round of national reform efforts recommend a shift from teacher-directed transmission approaches to instruction towards student-centered conceptual approaches to teaching and learning which emphasize the social and cognitive construction of knowledge and the integration of advanced technology (American Association for the Advancement of Science, 1989; National Council of Teachers of Mathematics, 1989; National Science Teachers Association, 1990). Technology plays a key role in this new vision. It is commonly believed that microcomputers can be used to effectively develop student understanding and individualize instruction (Fuson & Brinko, 1985; Goldman, Pellegrino & Mertz, 1987; Resnick & Ford, 1981; Suppes & Morningstar, 1972). Simply installing computers in public school classrooms and labs, however, will not change teachers' approaches to instruction. The way teachers integrate the use of technology into their teaching will be strongly influenced by their beliefs about the role technology can play in their instructional practice.

Over the past decade, researchers have documented the powerful effect of teachers' personal beliefs on their teaching practices (Buchman 1988, 1989; Bullough, 1989; Hollingsworth, 1989; Lortie, 1975; Zeichner, Tabachnick & Densmore, 1987). Personal perspectives, based on prior life experiences, have been shown to serve as major pedagogical driving forces throughout teachers careers. Of particular importance is the "apprenticeship of observation"—the thousands of hours they spent as pupils in grade school classrooms (Lortie, 1975). Teachers tend to draw on their own experiences as learners and often seek to create in their teaching those conditions that were missing from their own education (Knowles & Holt-Reynolds, 1991).

The majority of the current teaching force, however, have little experience in learning through technology. They were educated in classrooms that were relatively "computer free" and have limited personal experience to draw on in forming their perspectives on computer-assisted instruction (CAI). Thus, teachers look to the outside world for help, often relying on computer vendors to provide direction and training for the integration of technology into their classrooms. It is often a technology expert who chooses the software that is made available for teachers to use with students and provides training for teachers in the use of the software. In light of this, it is important to examine the relationship between teachers' beliefs about effective uses of CAI (ie. behavioral vs. constructivist) and the types of software (ie. Tutor, Tool, Tutee) that they use with students.

The present study will address how teachers beliefs about CAI relate to the types of instructional software they use, the types of computer related activities they provide for students, whether they integrate computer usage with other instructional activities and whether they have received training in various types of computer usage.

Method

Data sources, including factors derived from surveys completed by teachers, are described and explained in this section.

Data Source

The data presented in this study were collected through a statewide study which examined teachers' usage of technology in their classrooms. A set of questionnaires was mailed to every public elementary, middle, junior high and high school in the State. Two teachers per grade level grouping (K-2, 3-4, 5-6) were surveyed at the elementary level while three teachers per grade level grouping (7-8, 9-10, 11-12) were surveyed at the middle, junior high and high school levels. A total of 2170 usable surveys were returned (63%).

Questionnaire

The survey contained items which focused on teacher demographics; their beliefs about effectiveness of using computers in instruction; the amount frequency and type of CAI teachers engaged in; names, frequency of use, and subject areas for software they used; and the types of technology training they received.

Analysis of Teacher Belief Items

The questionnaire contained 18 items that evaluated teacher beliefs about CAI. Teachers rated how effective they believed computers to be in accomplishing a variety of goals such as "Introducing students to the subject," "Reinforcing each right answer," "Developing higher order thinking skills" and "Helping students to construct their own representations of concepts." Items were rated on a 5 point Likert scale in terms of how effective computers are when compared with more traditional forms of instruction (much less effective (1) to much more effective (5)).

The eighteen questionnaire items were entered into a Principal Component Analysis. The initial decomposition of the unadjusted correlation matrix extracted three factors with eigenvalues greater than 1 which accounted for 55.3% of the total variance in the matrix. Examination of a scree plot of the factors indicated that only two of the factors were viable. These two factors were retained and the factor matrix was rotated using the varimax method. The two factor orthogonal solution was theoretically meaningful and supported our decision to retain only two factors. These two factors accounted for 49.6% of the total variance in the matrix.

Two measures were used to examine the correlation matrix to determine if the data were appropriate for factor analysis techniques. Bartlett's test of sphericity was used to test the hypothesis that the correlation matrix is an identity matrix. The value of the test statistic for sphericity (Bartlett Test of Sphericity = 14089.800, $p < .001$) is large and the associated significance level is small, so it appears unlikely that the population correlation matrix is an identity. The Kaiser-Meyer-Olkin measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. In this analysis, the KMO value was .92880. Thus, correlations between pairs of variables can, to a large degree, be explained by the other variables. Both of these indicators suggest that a factor analysis is an appropriate technique to apply to these data.

Based on the five highest loading items on each factor, we developed labels for the factors. We named Factor 1 Student-centered Construction of Knowledge. This factor included the following identifying items:

Item 17: Helping students to construct their own representations of concepts (.80001).
Item 16: Allowing students to analyze data, draw inferences and generate their own problem solutions (.79705).
Item 12: Promoting student creativity (.76510).
Item 14: Providing experiences which enable students to discover concepts for themselves (.75075).
Item 10: Developing higher order thinking skills (.73913).

We named Factor 2 Computer-centered Transmission of Knowledge. This factor included the following identifying items:

Item 18: Providing students with practice in basic skills (.70999).
Item 7: Making sure students get the right answer (.70089).
Item 13: Providing drill and practice in the content required by the core curriculum (.68488).
Item 8: Reinforcing each right answer (.68173).
Item 11: Remediating student learning deficits (.57257).

Factor scores for each subject were computed using the regression method. These factor scores were used as an indication of how teachers believe computers can be effectively used in instruction for the subsequent analyses.

Comparative and Correlational Analysis

Teachers were asked to list up to four software packages they regularly used for instruction with students. These titles were coded and grouped into seven categories for analysis:

DP/ILS. Drill and Practice/Traditional ILS (Math Blaster, Reader Rabbit, SRA Math, IBM Math Practice
TEACHER TOOLS. Management Tools (Gradebook Plus, ICLAS)
KB. Keyboarding (Touchtyping, Typing Tutor)
INT/GAME. Interactive/Games (Carmen San Diego, Measurement, Time and Money)
TOOLS. Productivity Tools (Wordperfect, MS Word, Lotus 123)
EXPL. Exploratory (Logo, Geometric Supposer, Math Exploration Toolkit)
PRES/REP. Presentation/Representation (Hypercard, Linkway)

Individual teachers were assigned to groups based on whether they listed only software that reflects a traditional transmission orientation to CAI (DP/ILS, TEACHER TOOLS and KB), only software that can be used in more constructivist ways (INT/GAMES, TOOLS, EXPL and PRES/REP), or a combination of transmission and constructivist type software.

Analysis of Variance (ANOVA) was used to examine differences between the three categories (transmission, constructivist and mixed) on the two factor scores (constructivist and transmission).

In addition, factor scores were correlated with instructional activities that teachers use with computers and whether or not teachers had received training in specific instructional computing areas.

Results

The findings presented below analyze the relationship of teachers' beliefs about CAI to their classroom use of CAI and the training they have received for using computers in their classrooms.

Categories of Software Use

The ANOVA for categories of software use groupings revealed a main effect for the Student-centered Constructivist factor ($F(2, 1564) = 58.03, p < .001, MS_e = .952$). Post-hoc analyses using the Scheffe method revealed significant differences between the Transmission group and the Mixed group ($p < .01$), the Mixed group and the Constructivist group ($p < .01$), and the Transmission Group and the Constructivist group ($p < .01$) (see Table 1 for adjusted means and standard deviations). These results indicate that teachers who used more constructivist software had significantly higher scores on the Student-centered Constructivist factor than did teachers who used Transmission software or a mixture of Transmission and Constructivist software. In addition, teachers who used a mixture of Transmission and Constructivist software had significantly higher scores on the Student-centered Constructivist factor than did teachers who used only Transmission software.

A main effect was also found for the Computer-centered Transmission factor ($F(2, 1564) = 5.35, p < .01, MS_e = .917$). Post-hoc analyses using the Scheffe method revealed significant differences between the Transmission group and the Constructivist group ($p < .01$) and the Mixed group and the Constructivist group ($p < .05$). No difference was found between the Transmission group and the Mixed group (see Table 1 for adjusted means and standard deviations). These results indicate that teachers who used more constructivist software had significantly lower scores on the Computer-centered Transmission factor than did teachers who used Transmission software or a mixture of Transmission and Constructivist software.

Instructional activities

A series of Pearson correlation analyses examined the relationship between the two factor scores and (1) the types of computer activities teachers use with their students and (2) the types of other instructional activities teachers do along with computer activities in their classrooms. The matrix of correlation coefficients can be seen in tables 2 and 3.

As table 2 shows, the use of drill and practice software is the only variable that correlated significantly with the Computer-centered Transmission of Knowledge factor ($p < .01$). In contrast, The use of drill and practice software variable had a significant negative correlation with the Student-centered Construction of Knowledge factor ($p < .01$). All of the more elaborated uses of instructional computers (Word Processing through Graphics and Design Software) correlated significantly with the Student-centered Construction of Knowledge factor.

Table 2
Correlation of factor scores with whether teachers provide specific computer related activities for their students.

Computer Activities	**Constructivist Factor**	**Transmission Factor**
Drill & practice	-.0622**	.0941**
Word processing	.0762**	.0194
Interactive software	.0736**	.0224
Data management (dbase, spreadsht)	.0663**	-.0241
Exploration tools (simulations, microworlds)	.1049**	-.0023
Authoring programs	.0960**	-.0213
Programming Lang.	.0558*	-.0207
Class presentations	.0750**	-.0208
Access bulletin boards	.0684**	-.0240
Testing and assessmt.	.1098**	.0324
Graphics & design software	.0997**	.0160

Note. * = $p < .05$; ** = $p < .01$

Table 1: Adjusted means table: Factor scores arrayed by software categories.

Factor Type	**Constructivist Factor**			**Transmission Factor**		
Software Type	**Transmission**	**Mixed**	**Constructivist**	**Transmission**	**Mixed**	**Constructivist**
adj X	-0.323	0.005	0.366	0.103	0.068	-0.087
SD	1.002	1.003	0.913	0.963	0.912	1.010
n	453	637	477	453	637	477

Note. Scores represent adjusted mean factor scores. Constructivist Factor $F(2, 1564) = 58.03, p < .001, MS_e = .952$); Transmission Factor ($F(2, 1564) = 5.35, p < .01, MS_e = .917$)

Table 3 indicates that Student-directed Small Group Activities, Hands-on Activities or Experiments, and Research Projects correlate significantly with the Student-centered Construction of Knowledge factor while Review or Remediation correlated significantly with the Computer-centered Transmission of Knowledge factor, and Homework or Seatwork Activities correlated with both factors.

Staff development

Finally, we examined the relationship between the factor scores and whether or not teachers had received training in specific instructional computing areas (see table 4). On the Student-centered Construction of Knowledge factor, a pattern emerges that somewhat resembles the analysis presented in Table 2. Receiving training in Drill and Practice software correlated in a negative direction while training in the more elaborated uses all correlated positively. On the Computer-centered Transmission of Knowledge factor, receiving training in Drill and Practice Software was positively correlated, as were training in Word Processing, Programming Languages, Instructional Presentations, Testing and Assessment, and graphics and Design Software.

Discussion

These results indicate that teachers' beliefs about how technology can be effectively used in instruction can be differentiated into two discrete categories. Some teachers believe computers are tools that students use in collecting, analyzing and presenting information, while others believe that computers are machines that can be used to present information, give immediate reinforcement and track student progress. In addition, teachers' beliefs about effective uses of computers are closely linked with their use of computers in the classroom. Teachers who used more open ended, constructivist software with their students believed that computers can be used more effectively as a tool for student construction of knowledge while teachers who used more traditional behaviorist types of software believed that computers were effective as teaching machines. However, at this time, it is not clear whether teachers beliefs about effective uses of computers influenced the purchase of software in their schools, or whether the software that was purchased, and training teachers received, influenced teachers beliefs about how computers can be effectively used. In fact, evidence suggests that teachers frequently play minor roles in the selection of hardware and software that is used in their schools (Mergendoller, Stoddart, Horan, Niederhauser, & Bradshaw, 1992), so how these attitudes develop would merit further study. The largest group said they used both types of software and this group was positioned between the other two groups with respect to the student-centered constructivist factor but was more closely aligned with the traditional transmission group on the computer-centered transmission factor. It would be of interest to monitor this group to see if they move toward the constructivist or transmission end of the continuum.

Table 3
Correlation of factor scores with whether teachers integrate computer usage with other instructional activities.

Computer Activities	**Constructivivist Factor**	**Transmission Ftr.**
Student-directed small group activities	.1263**	.0280
Homework or seatwork exercises	.0585*	.0830**
Review or remediation	-.0208	.1500**
Hands-on activities or experiments	.2103**	.0190
Research projects	.1647**	-.0021

Note. * = $p < .05$; ** = $p < .01$

Table 4
Correlation of factor scores with whether teachers received inservice training in specific areas.

Inservice Topics	**Constructivist Factor**	**Transmission Ftr.**
Drill &practice	-.0637**	.0473*
Word processing	.0455*	.0455*
Interactive software	.0680**	.0270
Data management (dbase, spreads.)	.1090**	.0331
Exploration tools (sim-(ulation, microworld)	.1200**	.0282
Authoring programs	.1917**	.0237
Programming lang.	.0700**	.0484*
Instructional presentations	.0804**	.0621**
Accessing bulletin boards	.0786**	.0013
Testing and assessment	.0795**	.1013**
Graphics & design software	.0944**	.0693**

Note. * = $p < .05$; ** = $p < .01$

There was a correlation between the student construction factor and more integrated uses of computers with students. In examining the relationship between teacher perspectives on CAI and instructional use, we observed that teachers who believed CAI was most effectively used for student construction of knowledge were more likely to say they used computers in ways that go beyond traditional "teaching machine" uses of computers. These teachers provided a wide variety of activities for their students and were able to integrate computer applications. It is not surprising that these teachers also received training in these areas. However, the direction of this relationship is not clear, i.e., whether training influenced beliefs or whether their beliefs prompted teachers to seek out training. In contrast, there was a relationship between the transmission factor and using the computer for homework or seatwork and review or remediation. These types of activities are typically supported by the software typically found in an ILS.

Teachers' beliefs that computers were most effective for student construction of knowledge tended to reflect training in more elaborated uses of technology and they reported a variety of uses in their classrooms. Teachers who had higher constructivist factor scores had not had extensive training in the use of drill and practice software and tended not to use it in their teaching. The relationship between training and use of technology with students on the student-centered constructivist factor (tables 2 and 4) is striking. Once again, further study is needed to determine the direction of this relationship.

As might be expected there was an association between teachers' who had higher scores on the computer-centered transmission factor, the drill and practice computer activities they chose to use with students, and the training they had received. It is of interest that although there was a relationship between the transmission factor and receiving training in using drill and practice software, word processing, programming languages, instructional presentations, testing and assessment, and graphics and design software, only the drill and practice software correlated with activities with students. The other activities are, however, consistent with the transmission view of instruction. Computer programming is often taught through traditional transmission techniques. Instructional presentation software can be used as an electronic blackboard. Word processing and graphics/design programs can be used for preparing handouts, tests and other instructional materials, and testing and assessment programs are often included in ILS programs.

Although correlation values may be viewed as rather modest, they reveal an interesting pattern of relationships. The findings of this study indicate that teachers' beliefs about CAI are associated with their use of technology in instruction. One interpretation of the staff development data is that the training teachers receive may have a powerful influence on their beliefs about how technology can be effectively used in education.

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Parental Perceptions of Education, Technology, and Innovative Mathematics Instruction.

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Barbara goes to the computer lab once a week with her sixth grade class. There, she types in her password and the computer presents her with one math problem after another. She types in answers to each problem and, if she does well enough, she is given a new set of problems to do. At the end of the hour, she returns to her classroom. The computer lab assistant prints out a progress report for Barbara's teacher that shows the percent of correct answers Barbara gave. The teacher sends this printout to Barbara's parents once a month so that they can see Barbara's progress. At parent teacher conferences, Barbara's parents praise the teacher for the wonderful information they have about Barbara's math work.

Danny's sixth grade classroom has five computers in it. The students are allowed to work on the computer whenever they need it to help them in their work. For example, the students were asked to write a math problem using the five digits 5, 6, 7, 8, and 9, so that they could create the largest answer possible. After thinking about this with a friend for a few moments, Danny and his friend go to a computer and type in a problem. The computer gives them an answer. Danny and his friend discuss the result for a moment and then type a new problem into the computer. After several such tries, Danny and his friend announce that they believe they have found a way to use five digits to get the largest answer possible. Other students in the class discuss their ways to get large answers. The teacher gives a list of five different digits and asks the students to write problems that have small answers and defend their problems. Many students go to the computers to try out the problems they have designed. That week, at parent teacher conferences, several parents complain that they don't see many math problems coming home with their students. "Are they doing enough math? Will the students be ready for next year?" These are common concerns among the parents.

Comparing these two uses of computers in the classroom and the parent reactions to them poses some important concerns for both preservice and inservice teachers. Why do the parents feel that they know a great deal about Barbara's math work when what they have is a computer printout of math scores? Why are Danny's parents concerned about how much math he is doing and if he will be prepared for next year's work? In this paper we will focus on how existing parental beliefs concerning education impact their beliefs on the implementation of technology and innovative mathematics instruction. We have found that parents clearly view the importance of education in many different ways. The use of computers in education, and innovations in mathematics education that develop conceptual understanding and problem solving skills often challenge or reinforce these parental views.

Classroom uses of computers has increased extensively in the past two decades and varies from information delivery, drill and practice exercises, to an environment of problem solving for students (Papert, 1992). This extensive investment of resources, however, has not resulted in significant changes in instructional practices in the public schools. Parents desire that computers be a part of their children's education and believe that computers can enhance achievement scores (Visser, 1987). When computers are used in innovative ways, parents resist the nature of the instruction (Cobb, Yackel, Wood, Nicholls, Wheatly, Trigetti, & Perlwitz, 1991), preferring standard didactic practice. The support or resistance of innovative instructional practices by parents may influence their effectiveness.

Parent Perceptions of Education

Although educators have long recognized the importance of understanding cultural and family influences on students, previous research has focused upon the effects socioeconomic status and ethnicity has had upon limited outcome measures of education test scores. This study breaks with tradition by directly investigating parent beliefs concerning the purposes of education, the roles of education in the lives of their students, and how these perceptions influenced parental reactions to the implementation of mathematics and computer instruction.

The National PTA (1990), in a packet for parents entitled "Math Matters", defines several reasons for teaching mathematics: (a) learning about our everyday world, (b) job training as a key to the future, (c) being the best one can be, (d) gaining skills, and (e) gaining problem solving skills. These perceptions of the goals of mathematics education may or may not be held by most parents. In order to identify a variety of goals and purposes of education that parents perceive as important, informal records as a participant-observer and formal interviews were used. Constructs were identified and developed into a survey that was modified following a pilot study (Wentworth & Connell, in press). Seven purpose-of-education variables — (a) improve a student's chance for a good job, (b) expose students to the world around them, (c) help students reach full potential, (d) teach responsibility, (e) expose students to a cultural background, (f) teach skills, (g) prepare students to be problem solvers — in each of four areas of education: general education, the role of the teacher in education, mathematics education, and the role of the computer in education for a total of 28 variables.

Subjects

Five elementary schools in a large mid-western city were selected based upon the nature of their technology initiatives (i.e., ranging from a traditional integrated learning system (ILS) to a constructivist motivated approach) and their performance upon standard assessment measures (the schools roughly fell out a quintile apart, thus reflecting a broad range of measured abilities). Three thousand students took home surveys and about 1000 were returned. The average age of those returning surveys was 35, with 80% of the respondents female, 77% Caucasian, 1% African American, 8% Hispanic, 3% Hispanic, 3% Native American, 1% Pacific Islander, and 3% Asian (6% did not respond to this item).

At the time this survey was conducted, several of the participating schools were writing grants applying for computer equipment and training as part of the state Education Technology Initiative (ETI). As computer technology and implementations were in the forefront of parents' thinking as they worked with school leaders to prepare ETI proposals. The impact this may have had on the survey and its interpretation must be realized. For this population, the questions relating to computer use had already been the subject of much thought and reflection. It is likely that their responses more accurately reflect their true beliefs on these issues than a "cold" administration of the instrument would have achieved.

Factor Analysis Results

In order to interpret the survey variables measuring parent perceptions of education, we used a multivariate factor analysis, first with all the schools and then for each of the five schools. Factor interpretations were based upon how the variables loaded on the factor under consideration. Factors with loadings of .4 or higher were considered to have salient loadings in this study. This is a very conservative choice for the total population of approximately 1,000 participants, as it is within normal consideration for studies of approximately 175 where .3 is often the criterion (Gorsuch, 1983). A similar analysis was done for each of the five schools in the study after the factors for the total population were interpreted and named.

In the principal component factor analysis for the total population, six factors had Eigenvalues greater than 1 and were retained for further analysis. Using the variable loadings, the six factors were identified as follows: (a) job, (b) responsibility-potential, (c) world, (d) problem solving, (e) computer, and (f) teacher. The factors tended to fall on a continuum of explicit to implicit roles of education. The explicit learning included skills, facts, training, things external to an individual's character and easily measured like the job factor. Implicit learning was more personal, internal, not easily measured, such as learning responsibility, developing potential like the responsibility-potential factor. One potential significance of this finding could be that the parental perception of the roles of education includes the belief that personal and internal learning enhances skills and job training education.

Each school had a slightly different arrangement of these factors on the continuum of educational roles (Connell & Wentworth, 1993). In this paper, the results of the survey from two of the five schools will be discussed. School B and School D had very different computer implementations and so they will provide an interesting comparison of parent reactions and belief about computer technology and innovative mathematics instruction.

School B

School B was selected because the students' SAT Scores were approximately one standard deviation above the norm, and because of its computer lab, which is much like the ILS lab Barbara used to practice problems as part of the mathematics instruction. It had a middle to upper-class socioeconomic population. The average age of the 207 participants returning surveys was 37, and 77% were female. Seventy-eight percent were Caucasian, 5% African

American, 5% Hispanic, 2% Native American, 5% Asian. School B had been awarded an ETI grant one year prior to the time of this survey. Classes were scheduled with lab times during which students worked in CAI programs designed for their predetermined needs. Reports of progress were printed weekly, or upon teacher requests. Teachers could call up the progress reports and change the sequencing of any students work when desired. One computer lab aide had been hired to operate the lab and produce reports when requested.

School D

School D was selected for this study because its students had SAT scores one standard deviation below the norm and because of its plan for an innovative math program that would include technology. The population of this school was unique in the district because 30% of the students were non-English speaking students. Many of the non-Caucasian students were Asian, and many of the Caucasian families were immigrants from Eastern Europe. Only 117 surveys were returned and the average age of the parents participating was 33, 79% were female, 65% were Caucasian, 1% African American, 14% Hispanic, 3.5% Native American, 2.5% Pacific Islander, and 10% Asian. School D, the state university and a local computer business wrote the ETI grant for this school in a cooperative effort. The specific proposal included computers as part of the restructuring of math instruction. This restructuring required the inservicing of teachers in the constructivist theory and methodology, much like Danny's class. The grant was awarded and a lab of 18 computers was established. Most classrooms were also equipped with five additional computers that were networked with the lab. In addition to the inservicing of teachers in the constructivist approach to math education by faculty and graduate students from the university, teachers were instructed by the computer company in classroom management and CAI software.

The factor definitions for schools B and D are listed in Table 1. The responsibility and problem solving factors had the most diversity. At school B the responsibility variables were loaded on a technical factor that included some skill and job variables of computer and mathematics. School D had a responsibility-problem solving factor rather than one responsibility factor and one problem solving factor.

The factor analysis performed for the school indicates that the parents had a view of education that emphasizes explicit, technical and skill learning over implicit, personal, responsibility learning, especially compared to schools with similar populations. During the year before the survey was given to the parents, computers at School B had been used in a drill and practice lab to reinforce mathematics as well as other skills, much like Barbara's school. Mathematics was taught in a traditional instructional method and computers were used to reinforce skills, not develop problem solving abilities in students. Students were not asked to construct an understanding of the mathematics as they worked on the computers, they were just asked to type in answers that the computer scored.

At school D, where there was a mix of ethnic backgrounds, parents also had a very technical view of education. Two technical factors were defined at this school, a general job factor and a computer factor linked to math skills. The reaction of parents at school D to the constructivist mathematics and problem solving implementation of computers challenged these technical perceptions. Comments at parent-teacher conferences reflected the concern of parents that their child was not going to "know what he will need to know when he gets to junior high." The view that mathematics is a set of skills and that students are to practice those skills was challenged when students were asked to think about a problem and explain to the teacher what they were going to do to solve it, and then program the computer to perform the computations. Parents felt that their students would miss important skill training. Additional concerns included the "newness" of the instructional method. Parents would comment that "this was not the way I learned math."

Importance to Teacher Education

We draw two important conclusions from this study of parent perceptions of education. First, the factors defined from the total population show that parents perceive education as both implicit and explicit. Second, teachers need to be aware that many parents will not understand innovative mathematics instruction and technology in the classroom when parents view education from a more explicit, technical framework.

As innovative mathematics instruction and the implementation of computers at school D shifted toward problem solving, parental perception of the technical, skill-training role of education was challenged. The innovative math-

Table 1
Factors Definitions

	Factor 1	Factor 2	Factor 3	Factor 4
School B	Computer	Job	Technical-Responsibility	World
School D	Responsibility Problem Solving	Computer	Culture	Job

ematics program at School D failed to meet existing parent beliefs about the importance of explicit learning. Regardless of its merit, it was not recognized as worthwhile. Conversely, the ILS program at school B mapped closely to existing parent beliefs and was rated unreasonably high regardless of its lack of educational power. Educators should be aware of these concerns and inform parents about the nature of the innovations, emphasizing the strengths and importance of students constructing meanings to algorithms.

Teachers need to include parents in the understanding of innovative mathematics instruction. Parents can learn the importance of the internal and personal roles education plays in the development of their students. Learning goes beyond drill and practice of skills solely for the purpose of job training. Teachers using computers to enhance innovative mathematics instruction can inform parents about the problem solving thinking being done in the classroom. Danny and his friend created the problems and used the computer to calculate answers. Then they evaluated what they had learned and created new problems that required another calculation. Through this activity of problem solving, Danny and his friend interacted with each other, reasoned about number relationships, and communicated their mathematical thinking with each other and the class.

As teachers involve parents in understanding these varied roles, learning may become more internalized. A valuable by-product of this internalization of educational roles may be the concurrent increase of standardized test scores. It should be emphasized that the importance of internalizing learning and stressing implicit roles of education is only a possible factor in increasing test scores. As parents and educators alike stress the implicit side of education, the importance of using standardized test scores to evaluate the success of education may be lessened. Further research on parental perceptions of education could focus on the impact belief systems have on the emphasis parents place on standardized test scores.

Further study of the factor patterns of these variables could indicate parental perceptions of relationships between education and teacher variables, teacher and mathematics, and mathematics and computer variables, between education and mathematics, education and the computer, and between teacher and computer variables. Strong relationships between teachers and computers would support the didactic, explicit views of education and indicate the need to educate parents about constructivist methodology to insure some acceptance of computer and mathematics innovations.

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Prospective Teachers' Use and Perception of the Value of Technology

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In the pursuit of educational excellence, the quality of teacher education has become one of the major issues. How to adequately prepare prospective teachers to meet the challenge of the profession has gained great attention, particularly in a changing society where the information explosion and technological advancement have made the profession tremendously demanding. To deal with the challenge many educators have advocated the integration of educational technology into teacher training. The need for educational technology is based on the concept of providing a variety of materials, equipment, and instructional modes to enhance the teaching and learning process.

Educators seem to assert that educational technology has enormous potential to improve education practice. The Office of Technology Assessment (1988) has published an assessment of the integration of new technology into classrooms Its report includes a description of the pre-service requirements for new technology in each of the states. A great number of researchers have studied the implementation of technology in teacher education. The challenge that new technology such as interactive video, computers, and so forth presents to teacher training and the program that aims at enhancing teacher preparation in technology has well been documented (American Association of Colleges for Teachers, 1987; Association for Educational Communication and Technology, 1981; Bosworth & Welsh, 1993; Byrum & Cashman, 1993; Reyes, Torp, & Voelker, 1993; Robinson, 1993; Woodrow, 1993). Other researchers of technology and teacher education have focused on teachers' attitudes and characteristics (Day & Scholl, 1987; Huang, Copley, Williams, & Waxman, 1992; Liao, 1993). These studies cited improved instruction, effectiveness, and time saving as the rationale for engaging in educational technology activities. What has rarely been explored is the relationship between prospective teachers' use and perception of the value of educational technology. Similarly, some student teacher characteristics like gender, age, grade-level taught, subject area, media and computer facilities at home, faculty influence, and previous teaching experience have not been specifically investigated in terms of their relationship to prospective teachers' use or perception of technology. This study explored these relationships. More specifically, this study addressed three research questions:

1 What are student teachers' utilization and perception of the value of educational technology?
2 Is there consistency or discrepancy in prospective teachers' perception of the value and actual use of educational technology?
3 How do teacher characteristics relate to utilization and value perception of technology?

Methods

The subjects consisted of student teachers enrolled at three universities located in the Central south. A total of 287 student teachers were administered surveys. Of the 158 responses usable for the present study, 131 (83%) were female and 27 (17%) were male. Their ages ranged from 21

Table 1
Student Teachers' Characteristic Profile

Variable	f	%
Gender		
Male	27	17.1
Female	131	82.9
Age		
Unspecified	2	.
21-25	51	32.7
26-30	30	19.2
31-35	31	19.9
36-40	24	15.4
41-52	20	12.8
Subject		
Unspecified	2	.
All Subjects	89	57.1
Reading/Language	26	16.7
Mathematics	5	3.2
Science/computer	10	6.4
Biology/Life sc..	4	2.6
Social science	18	11.5
Economic/business	2	1.3
Special Education.	1	0.6
Health/PE.	1	0.6
Previous media or computer experience		
Unspecified	8	.
Yes	67	44.7
No	83	55.3

Variable	f	%
Grade Level		
Unspecified	2	.
Elementary S.	97	62.2
Junior High S.	9	5.8
Secondary S.	9	5.8
Senior High S.	41	26.3
Race		
unspecified	1	.
White	140	89.2
Black	7	4.5
Hispanic	9	5.7
Asian	1	0.6
Technology Facilities at Home		
Unspecified	2	.
Yes	129	82.7
No	27	17.3
Previous teaching experience		
Unspecified	2	.
Yes	70	44.9
No	86	55.1
Faculty Influence		
Positive	115	72.8
Neutral	41	25.9
Negative	2	1.3

to 52 with a mean of 31. A great majority of them (89%) were white. About 62% of them taught in elementary schools and 27% taught in high schools. Over 55% of them taught all subjects. Table 1 presents these teachers' characteristic profile.

The measuring instrument is the Educational Technology Use Questionnaire (ETUQ). The ETUQ lists the 10 most-often identified technology activities associated with the teaching profession. Student teachers indicated their value estimation of each technology activity on a five-point Likert-type scale and indicated the frequency of their participation in each activity during the semester. The alpha reliability coefficient is .86 for their value perception and .68 for their participation. The survey questionnaire appears to cover relevant content. Student teachers' responses on these activities are considered realistic measure of their educational technology involvement. The ETUQ was administered to the subjects toward the end oY their student teaching semester. Two weeks later, a follow-up letter and a survey questionnaire were mailed to the subjects whose responses had not been received. The responding rate was nearly 60%.

Descriptive statistics were used to provide means, standard deviations, and ranks of the ten technology activities. Student teachers were then divided into three groups according to their perceptions of the value of educational technology. Student teachers with a total perception value below 38 were in the low-perception group, those with a total perception value between 38 and 44 were in the median-perception group, and those with a total perception value above 44 were in the high-perception group. An analysis of variance (ANOVA) was used to compare the frequency of technology use among the three groups of student teachers. Multiple regression was employed to determine whether there were significant effects of these prospective teachers' characteristic variables on their perceptions of the value and actual use of educational technology.

Results

Table 2 reports descriptive statistic results. The results revealed that, in general, student teachers perceived the value of educational technology very highly. They perceived each educational technology activity with a mean value of 3.56 or greater with an overall mean value of 3.93 (on a five-point scale). Among the ten activities, the most highly valued activity was learning to operate audio-visual machines, followed closely by using media for classroom presentation. The least valued activity was using closed circuit TV or a camcorder for taping and diagnosing student learning in the field. Student teachers' actual utilization of educational technology was relatively low as compared to their value perceptions. The average number of times they engaged in each type of technology activity ranged from .59 to 3.32 with a mean of 1.89 during their student teaching semester. They used media for classroom presentation most frequently, but seldom used closed circuit TV or a camcorder for taping and diagnosing student learning. Rank orders reveal some discrepancies between student teachers' use and perceptions of the value of educational technology. For example, learning to operate audio-visual machines was ranked first in their value perception but ranked third in their actual use. Likewise, the rank orders of using computer facilities to add instruction and to locate library materials were both off by two ranks. The standard deviations for use were generally larger than for value perception, suggesting

Table 2
Means, Standard Deviations, and Ranks of Student Teachers' Use and Perception of the Value of Educational Technology Activities

Technology activities	**Value Perception**			**Use**		
	M	SD	Rank	M	SD	Rank
Using computer facilities to add instruction	3.95	1.29	4	1.84	2.07	6
Using computer terminals to locate library materials	3.82	1.51	6	2.16	2.21	4
Using media for self-instruction	4.02	1.21	3	2.37	2.09	2
Using media for group study	3.59	1.30	9	1.38	1.85	8
Using media for classroom presentation	4.42	.97	2	3.32	1.84	1
Learning to operate audio-visual machines	4.46	.99	1	2.35	1.90	3
Using audiovisual equipment for taping and evaluating teaching demonstration	3.75	1.32	8	1.25	1.30	9
Using a closed circuit TV or camcorder for taping and diagnosing student learning in the field	3.56	1.32	10	0.59	1.06	10
Developing audio-visual aids	3.91	1.24	5	1.96	2.06	5
Purchasing educational technology products and services	3.78	1.33	7	1.70	2.05	7

Table 3
Means, Standard Deviations, and F value of the three groups of student teachers' frequencies in technology use

Group	Low	Median	High	F
n	53	53	52	
M	11.56	16.60	19.18	15.50***
SD	5.71	7.26	8.27	

***p<.001.
Note. The underline that connects the two means indicates there was no significant difference between the two means.

that there was a greater variance in use than in perception of the value of educational technology among student teachers.

ANOVA results indicated that there was a significant difference among the three groups of student teachers (F=15.50, df=2/155, p<.001). Further analysis using post hoc multiple comparison indicated that student teachers with high and medium perceptions of the value of educational technology actually used technology more frequently than student teachers with low perception. Table 3 presents the means, standard deviations, and F value of the three groups.

The Pearson correlation result confirms the positive relationship between student teachers' participation in and their perception of the value of educational technology

Table 4
The Beta Weight, Probability, and Tolerance Values of Student Teachers' Characteristics on Their Use and Perception of the Value of Educational Technology

Characteristic	**Value**		**Use**		
Variables	Beta	Probability.	Beta	Probability	Tolerance
Gender	.35	.0001***	17	.0390*	.74
Age	-.21	.0086**	-.11	.1486	.91
Race	-.07	.3615	.05	.4816	.95
Grade level	.03	.7094	-.08	.3422	.80
Subject taught	-.07	.3631	.02	.7584	.95
Previous teaching experiences	.03	.7027	-.01	.8835	.85
Previous media or computer experience	-.13	.1034	-.04	.6045	.97
Technology facilities at home	-.02	.8371	-.12	.1143	.92
Faculty influence	.18	.0236*	.43	.0001***	.89

*p<.05. **p<.01. ***p<.001.

activities. The correlation coefficient (r=.41) indicates there was a moderate and significant correlation between these two variables.

The multiple regression results revealed that student teachers' characteristic variables have an overall significant effect on their technology use (F=6.80, p<.001) and perception of the value of educational technology (F=4.87, p<.001). Characteristic variables explained about 32% of the variance in student teachers' use and 25% of the variance in their perception of the value of educational technology Student teachers' utilization of technology was significantly correlated with gender and faculty influence (positively). Student teachers' perception of the value of technology were correlated not only with gender and faculty influence (positively) but also with age (negatively). The tolerance values for the nine characteristic variables were rather high (all above .70), suggesting that there was little multi-collinearity among these characteristic variables. Table 4 presents the beta weight, probability, and tolerance values of each characteristic variable on student teachers' use and value perception of educational technology.

Discussion

The results of this study indicate that preservice teachers have high perceptions of the value for technology and that value perception played an important role in student teachers actual use of technology. The greater the student teachers valued educational technology, the more frequently they used educational technology. Nonetheless, the results also revealed that technology activities are relatively underutilized as compared to the value perceived by student teachers. In addition, there is a gap between value perception and utilization as shown in the rank orders of these technology activities. For example, computer aided instruction was ranked fourth in value perception but ranked sixth in actual use. Learning to operate audiovisual machines was ranked first in value but ranked third in actual use. Student teachers tended to utilize technologies which were not technically complex or did not require elaborate preparation. This discrepancy raises some concerns. It implies more training and preparation in technology may be needed to help these prospective teachers become more competent and comfortable at integrating technology into teaching and learning processes.

The results also suggest that several characteristics such as gender and faculty influence were related to use and perception of technology. In general, female student teachers perceived a higher value for technology and used technology more frequently than male student teachers. One possible explanation of this gender-related difference is that most female student teachers taught at lower grade levels and thus tended to engage in more educational technology activities. Correlational findings reveal that grade-level taught was negatively related with technology use. The higher the grade level, the less technology is used. Thus, whatever relationship grade level has with technology use is redundant in the preclusion of the gender variable.

The present study further reveals that student teachers who had more positive faculty influence also demonstrated higher value perception and greater use of educational technology than those who did not. Teacher influence has been well documented (Cuban, 1984; Kavina & Pedras, 1986). In the teacher education domain, faculty members serve as role models. Their use of and attitudes toward educational technology has significant impact on student teachers' implementation of education technology. Faculty members generally took a positive attitude toward educational technology, but utilized technology only some of the time. They viewed high-tech media as valuable, but in practice they favored traditional types of instructional materials. Similar discrepancies exist between student teachers' use and value perception of educational technology. Because college of education professors usually have influence on prospective teachers' perception and behavior, colleges of education should provide special programs or workshops to facilitate faculty utilization in this domain .

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Are Your Students Like Mine? Preservice Students' Entering Technology Skills.

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There is no question that the number of microcomputers in K-12 schools has increased over the years. In 1981, it was reported that there were 15,000 schools with computers. That number had grown to about 77,000 by 1988. The number of elementary and secondary schools that has at least one computer has increased from 18% in 1981 to 95% in 1988. As of the late 1980s, there were between 1.2 and 1.7 million computers in U.S. public schools, which translates into an average of 1 computer for every 30 children (OTA, 1988).

With more and more students in K-12 schools having access to computers, it might be expected that high school graduates, particularly those who go on to higher education, have some degree of computer literacy skills. Recent research suggests, however, that most college students have not had much experience with a personal computer prior to entering the university. A 1991 survey conducted at the University of Massachusetts at Amherst found that slightly more than half (50.9%) of the students had used a personal computer "very little" or "not at all" before coming to the university, 31.6% had used a PC "somewhat," and 17.6% had used a PC "a great deal" (McAulay, 1993). Similar results have been found by researchers examining computer literacy trends in preservice teacher education, where most students are female. Cardinale's (1992) findings suggest that the majority of female preservice teachers lack extensive prior experience with computing; the experience they do have is limited to word processing, data bases, and games.

This paper examines the technology skills of preservice teachers at a small regional public university. The major motivation for the study was the apparent discrepancy between access to computer technology in high school and the actual skills of the students as demonstrated at the beginning of an introductory educational computing course. In general, students exhibited a lack of familiarity of both computer hardware and software. Anecdotal evidence, however, is an inadequate source of information for making important curriculum-related decisions. Thus, it was decided to collect, over several semesters, quantitative information about the nature of students' computer literacy skills. This information could also be used as a needs assessment for the design of educational technology courses.

After an overview of the demographics of the university and a brief description of the College of Education, the data collection process is described. The data analysis is then presented followed by a discussion of the implications of the findings in relation to the ongoing refinement of the teacher education curriculum.

Institutional Description

The university where the study was conducted is a small public institution serving a regional population. There are approximately 6,000 students enrolled in undergraduate and graduate programs. In 1991, the mean SAT score was 850, 7% of the students were from the top 10% of their high school class, 59% of the students were from the top half of

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their high school class, and 50% of the students graduate in 5 years (U.S. News and World Report, 1992).

The College of Education is the second largest in the university in terms of student enrollment (the largest is science and technology). There are currently about 1,900 students enrolled in programs in the college. Students can choose one of eight majors leading to certification. The College of Education has recognized the importance of computer technology in the undergraduate curriculum. All undergraduate majors are required to complete an introductory educational computing course. In the course, students study computer operations, common productivity tools (word processing, data base, and spreadsheet), and instructional software. The College maintains a Macintosh computer lab as a resource for the course.

Recent discussions with colleagues reflect a desire revise the teacher education curriculum, moving away from such widely used applications as word processing toward advanced computer-based multimedia applications, e.g. CD-ROM and laser disk technology. Such a change would require basic computer literacy as a prerequisite to an advanced educational technology course.

Data Collection

Data for the study were collected from students enrolled in the introductory educational computing course during 7 semesters from the fall of 1991 to fall of 1993. Students were asked to complete a questionnaire at the second class meeting of the semester. The questionnaire required that students evaluate themselves using a Likerttype scale on seven areas pertaining to computer literacy: hardware, operating system software, Macintosh equipment, word processing software, data base software, spreadsheet software, and the use of a mouse. The scale ranged from 1 = no experience, to 3 = basic familiarity, to 5 = expert.

The numbers of respondents by semester are indicated in Table 1. The gender composition of the sample remained fairly constant across semesters, averaging about 29% male and 71% female. The sample consisted primarily of juniors (approximately 48%), followed by seniors (approximately 26%). Given this distribution of upperclassmen, it might be expected that most students would have had an opportunity to develop some computer literacy skills before enrolling in the course.

Table 1
Students Completing Computer Literacy Survey by Semester

Semester	Number of Respondents	
Fall	91	95
Spring	92	99
Summer	92	28
Fall	92	96
Spring	93	100
Summer	93	29
Fall	93	77
Total		527

Data Analysis

Preliminary analysis of the data revealed that there was little variation in response patterns across semesters for any of the seven literacy areas (hardware, operating system software, Macintosh equipment, word processing software, data base software, spreadsheet software, and use of a mouse). Thus, the data per semester for each literacy area were combined to facilitate presentation of the findings.

The results reveal that most preservice students have little awareness of the seven computer literacy areas. In the areas of hardware, operating system software, Macintosh equipment, data base software, and spreadsheet software, over 70% of the students indicated less than basic familiarity with the topics. More students are familiar with word processing and the mouse; a little over 60% indicated less than basic familiarity. The complete distributions of responses for the seven computer literacy areas are presented in Figures 1 to 7.

Figure 1 depicts the results for hardware. Approximately 73% of the students indicated less than basic familiarity with computer hardware; approximately 27% indicated at least basic familiarity.

The numbers are comparable for operating system software, as shown in Figure 2: approximately 72% had less than basic familiarity; approximately 28% had at least basic familiarity.

As shown in Figure 3, approximately 23% of the students had at least basic familiarity with Macintosh equipment while approximately 77% had less than basic familiarity. Consistent with the finding that most schools still use Apple II equipment, this is gradually changing as more DOS-based and Macintosh machines are being purchased.

As Figure 4 depicts, students are more familiar with word processing than other types of software. Approximately 61% have less than basic familiarity and approximately 39% have at least basic familiarity with word processing software. These numbers may reflect the availability of word processing resources on campus. A writing center as well as an instructional computing center provide facilities for students to use a word processor for writing assignments that are required for other courses.

In contrast to the higher level of competency with word processing software, figures 5 and 6 show that few students are familiar with data base and spreadsheet software. Approximately 83% of the students indicated less than basic familiarity with data base software and approximately 17% indicated at least basic familiarity. The numbers for spreadsheet software are 85% and 15%, respectively.

Finally, as shown in Figure 7, approximately 63% of the students indicated less than basic familiarity with a mouse, and approximately 37% indicated at least basic familiarity. It is difficult to explain how so many students are familiar with a mouse if consideration is given to factors reported earlier: only 23% use a Macintosh and most K-12 schools

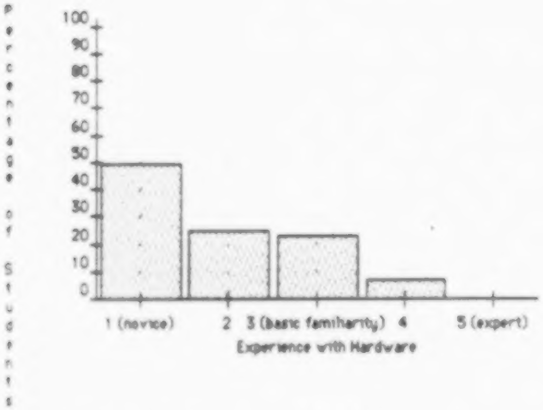

Figure 1. Hardware All Semesters.

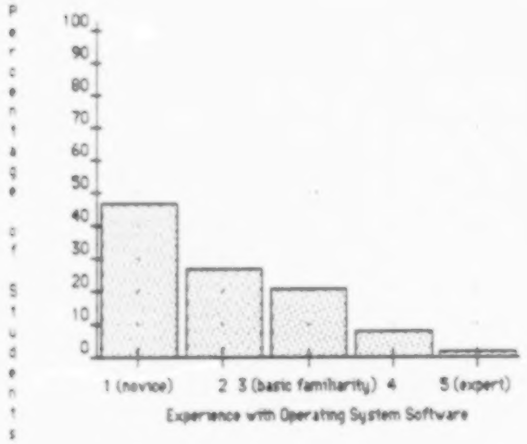

Figure 2. Op Sys Software All Semesters.

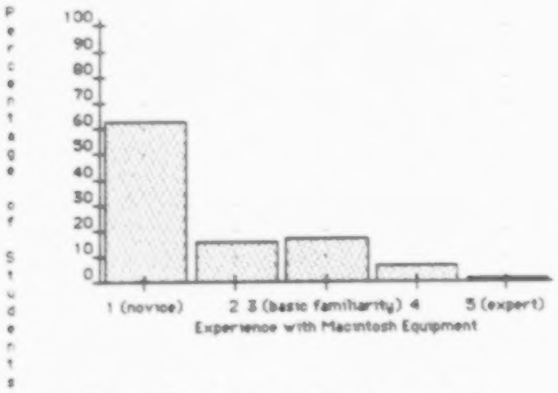

Figure 3. Macintosh all Semester.

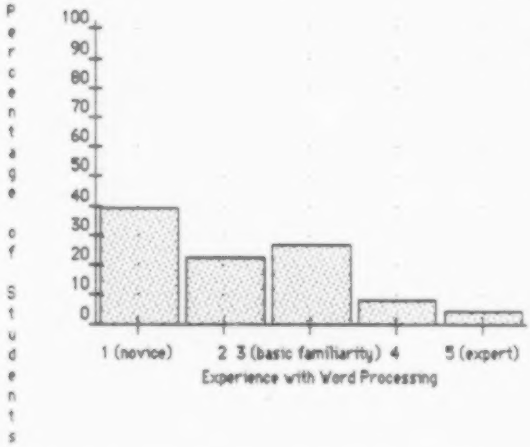

Figure 4. Word Processing All Semesters.

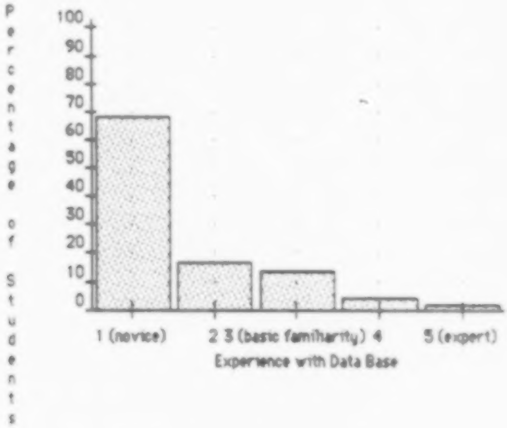

Figure 5. Data Base All Semesters.

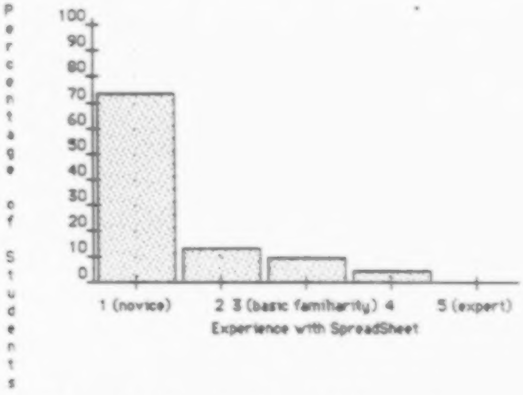

Figure 6. SpreadSheet All Semesters.

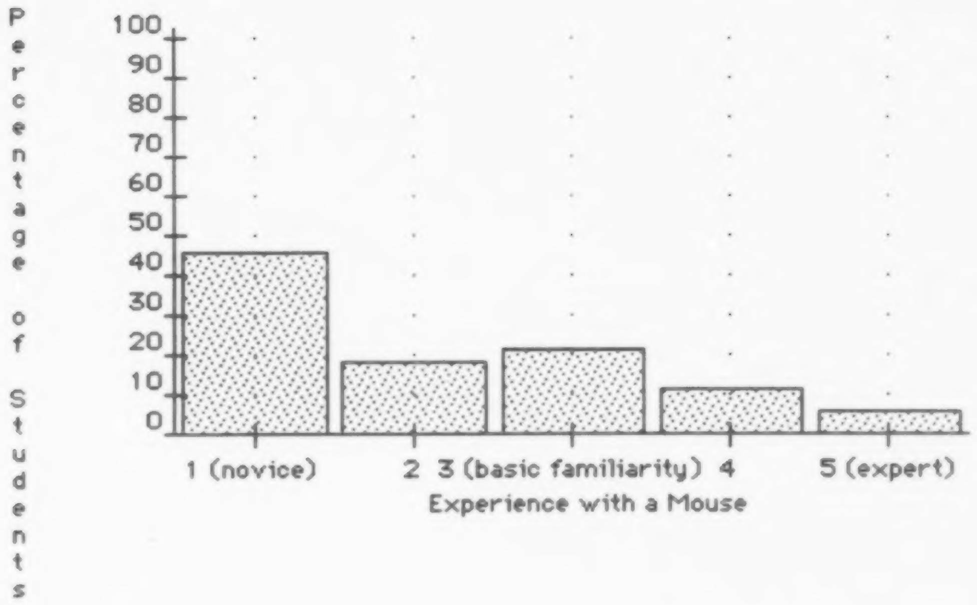

Figure 7 - Mouse All Semesters

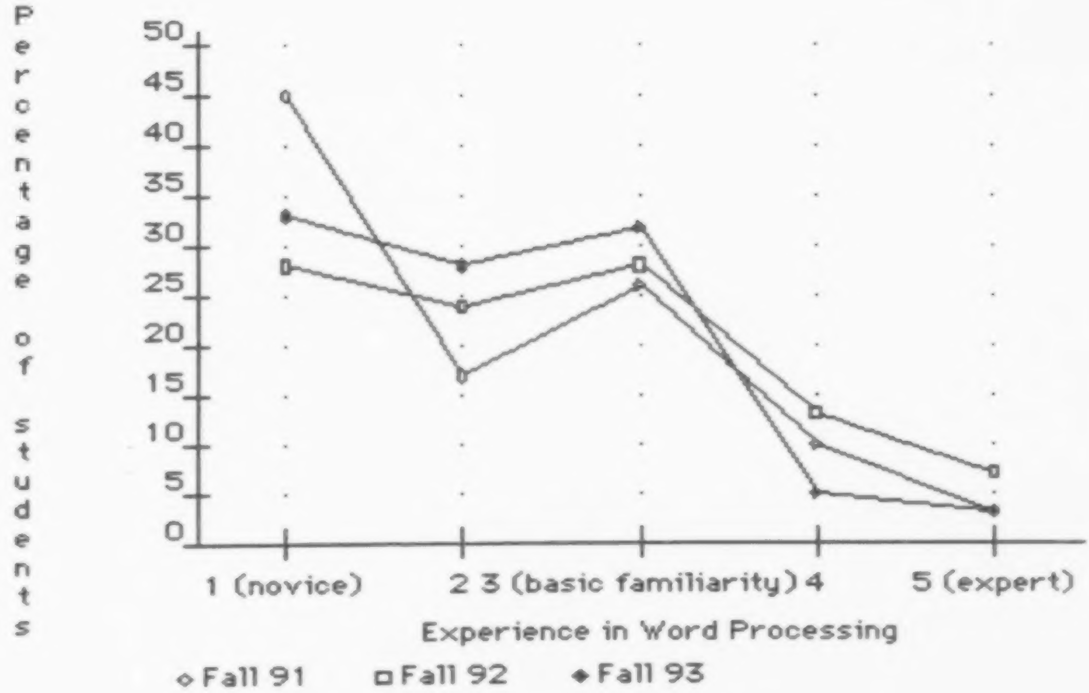

Figure 8. Word Processing Change.

still use Apple II hardware. The discrepancy may be due to a misunderstanding of the definition of a mouse and the related confusion of other input devices such as a joystick or game paddle.

Discussion

The preponderance of computers in K-12 schools has placed substantial pressure on teachers at all levels to enhance their computer literacy skills. The pressure has trickled down to teacher education programs, and they are slowly responding. Using state departments of education regulations as a barometer, the Office of Technology Assessment (OTA) reports that in 1988, half of the states neither *required* or *recommended* technology preparation for preservice teachers. Seven states *recommend* that some preservice training be taken. Eighteen states and the District of Columbia *require* that all students in certification programs develop competencies in computer technology (OTA Report).

The results of this research indicate that preservice teachers enrolled in their first educational computing course have little skill in computer literacy areas, even though the majority are juniors and seniors. This is consistent with a study conducted at the State University of New York at Buffalo, where it was reported that over 50% of 324 preservice teachers never used a computer during their college experience (Beaver, 1990).

There is speculation that as access to computers in K-12 schools increases, more students will be entering the university with computer literacy skill. The results of this study does not bear this out. Figure 8 shows the change in word processing skills of students from the fall semesters of 1991, 1992, and 1993. There is a negligible difference in student competence in all ranges over the three semesters.

There is also speculation that soon students in elementary, middle, and high schools will know more about computers than their teachers. This may be true already, as Brosnan (1990) concluded that although computers are in the schools, most teachers aren't comfortable using them. Given the rapid growth in access of computer technology in the schools, the knowledge gap between teachers and students may in fact continue to widen. Preservice teacher training programs must prepare the next generation of teachers for the technology they will face in the schools.

Conclusion

It is clear that preservice students have little knowledge about educational technology when they enter the teacher education programs. When they enter the teaching profession, they may be expected to know at least as much about technology as their students, or risk losing their credibility. The top ten computer skills needed by new teachers, according to a recent survey (Hurteau, 1990), are listed in Table 2.

Table 2
Rankings of Computer Skills Needed by new Teachers

Rank	Topic
1	Word Processing
2	Computer in Curriculum
3	Introduction to Computers
4	Subject Area Training
5	Teacher Utilities
6	Database Management
7	Desktop Publishing
8	Graphics
9	Spreadsheets
10	Minor Hardware Maintenance

Teacher education programs face many challenges in preparing their students to meet these expectations within the constraints of the present curriculum. Technology is changing rapidly, and although prices are decreasing, the cost of technology is still demanding on university budgets. Proposed changes in accreditation guidelines require resources, equipment, and staff development. Faculty development is critical; faculty can't teach what they don't know.

Creative and systematic strategies involving the whole university, not just the college of education, may lead to institutional strategies for solving this problem. For example, an undergraduate computer literacy competency as a general education requirement would free the teacher education program (and other disciplines as well) from having to focus on basic computer literacy, enabling them to concentrate on advanced educational computing.

If the role of teacher education programs is to produce teachers who are able to use the new computer technologies, we must take our preservice students from where they are when we get them and advance them to where the technological society needs them to be.

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Teachers and Technology: Total Quality Reform (TQR)

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Teacher education is being scrutinized by leaders in education from national, state, and university levels as well as by members of the United States Congress. Researchers are wrestling with the question of how to develop the optimum structure of higher education, as well as teacher preparation programs, to address current issues and concerns (Johnson & Marcus, 1987; Fulton, 1993). Higher education administrators are challenged increasingly to offer higher quality performance as well as to increase the efficiency and effectiveness of the organizational processes.

Education reform has been debated heavily for more than a decade. A Nation at Risk (1983) spawned the multitude of current reports and reform efforts from private and public commissions. A common thread running through the reports of the 80s was that mediocre education presented a threat to the nation's global preeminence (Ascher, 1984). Restructuring ideas and piecemeal concepts have surfaced frequently and many have been tried. American education systems jump individually, and often with insufficient thought, into implementing new solutions to problems. Too little time, thought, and energy are spent on developing policy and planning needs to implement actions.

The teacher education majors beginning college in the fall of 1994 will spend most of their teaching careers in the 21st century. The implication from the research is that schools of the 21st century will be very different from the schools of today (Harrison, 1987). Change is necessary, therefore, in teacher preparation programs. Teachers must be prepared to address the needs of students and to prepare students for challenges they will face in our rapidly changing technological world.

Many professionals interested in education recognize the need for the integration of information technologies in all areas of education. These same professionals would agree that, although great strides have been made during the past decade in the use of technologies in the classroom, there is still a need for considerable planning and effort if advancement will occur for the teachers of the 21st century (Glenn & Carrier, 1989). Most educators agree that the use of technology in the working world will only grow. Handler (1993) reports that only 29% of preservice teachers feel prepared to teach using computers. Criswell found that first-year teachers simply are not confident in using varied technologies in their classrooms (cited by Handler, 1993). Several questions arise:

- Are teacher education programs in the United States preparing teachers to use technology in their classrooms?
- Are faculty members using technology for instructional purposes? In other words, are teacher education faculty teaching with technology or teaching about technology?
- Are preservice teachers encouraged to teach with the aid of a computer in their field experiences or student teaching experiences?
- Assuming that teacher education is reformed appropri-

ately, what is our mission for ensuring that administrators will recognize and support technology-using teachers?

Answers to these questions are critical if technology is to play a significant role in education. Scholarship, both quantative and qualitative, that addresses these questions is sorely needed today and should be a major component of the research agenda for information technology and teacher education for the foreseeable future.

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Prospective Teacher's Attitudes Toward Computers

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A wide variety of technologies is currently used in educational settings (Mitchell & Paprzycki 1993, Paprzycki & Mitchell, 1991, Vidakovic & Paprzycki, 1993). However, within the last couple of years, most of these technologies are being used (and enriched) in a computer-based environment. It is obvious that it will be teachers (present and future) who will play a decisive role in how successful the technology will be in education. At the same time, there seems to linger a widespread belief that teachers are more hesitant and less likely to embrace computer technology than other professionals.

We have decided to investigate the validity of this belief on a population of prospective teachers and examine students' attitudes toward computers in relationship to gender, age and academic major. We developed a survey to examine the level of computer anxiety. The aim of this paper is to present the preliminary results of our study.

Methodology

To obtain measures of students' attitudes toward computers, we used a simple and widely used self-report survey with questions written in a Likert scale format (Grounlund, 1981). A list of favorable or unfavorable attitude statements was presented and students were asked to respond to each statement on a five-point scale: strongly agree, agree, undecided, disagree, and strongly disagree (see Appendix 1 for the complete survey). The scoring of a Likert-type scale was based on assigning weights from 1 to 5 for each position on the scale (the weights for unfavorable questions were reversed).

Questions were combined into four groups representing particular areas of interest. Questions 1, 2, 4, 6, 7, 8, 9, 16 and 21 characterize the individuals' current feeling about computers. Questions 3, 5, 17, 20, 22 and 24 assess the perceived need for the computer (in the past, presently and in the future) and the perceived role of computers (in the present and in the future). Questions 10, 11, 13 and 15 address the individuals' attitude toward learning. Questions 12, 14, 19 and 23 deal with the attitude toward the Computer Literacy course itself.

Three major factors were considered: academic major, gender and age. For each of these factors a comparison was run inside each school and between the two schools. For the academic major we have made two comparisons: teachers vs. non-teachers and a five-way comparison between the prospective teachers, natural science students, arts and humanities students, business students and undecided. The results were statistically analyzed using ANOVA combined with the Duncan's multiple comparison test (for the statistically significant ANOVA results). For the Duncan's multiple comparison test the standard significance level of 0.05 was used.

During the Fall 1993 Semester a total of 69 surveys were collected at the University of Hartford (UH), an urban university in a major metropolitan area. They consisted of 33 females and 36 males, 68 youngstudents and 1 older student (where young is defined as up to 25 years old), and 2 prospective teachers. During the Spring 1993, Summer

1993 and Fall 1993 a total of 62 surveys were collected at the University of Texas of the Permian Basin (UTPB), a state-supported regional university in a predominantly rural area. They consisted of 16 females and 46 males, 30 younger and 32 older students and 22 prospective teachers. Since the number of prospective teachers and older students at UH was small, the comparisons between teachers and non-teachers, as well as, older vs. younger students were performed for the UTPB only.

Results

Data relative to overall attitudes, feelings about computers, opinions about the role of computers, and attitudes toward the role of computers and toward learning were analyzed.

Overall attitude

The primary thrust of our study was to compare the prospective teachers with students in other majors. The results were somewhat surprising. We found no significant difference between prospective teachers and the rest of the student body in the overall attitude toward computers and on question by question basis. When comparing all five groups of majors (combined from both schools) there was also no difference between their overall attitude toward computers. These results argue against the notion that prospective teachers have an anti-technological attitude. They also suggest that the difference in attitudes toward computers may not depend upon the academic major. We found that students at UTPB had more positive overall attitudes toward computers than the students from UH. Significant differences in the overall attitude toward computers were also observed when age and gender were considered. We found that UTPB young students were more positive toward computers than UH young students. At the same time there was no significant difference between young and old UTPB students. UTPB female students are more positive toward computers than UH female students; there was no difference between male students between the two schools or between male students and female students inside each school.

Feelings about computers

There was no difference between the two schools in general, between the majors, or teachers and non-teachers at UTPB in terms of feelings about computers. Young students from UTPB felt more comfortable with computers than young students from UH. They were also more comfortable with computers than the older (UTPB) students. There were no significant gender differences.

Role of computers

Overall, UTPB students were more positive as far as the assessment of the role of computers and their future computer needs than UH students. There was no difference between the majors, teachers and non-teachers at UTPB, or young students in both schools. At the same time older students at UTPB are more positive than younger students. There was no difference between UH female students and UTPB female students. UTPB male students were more positive in their assessment of the role of computers than UH male students. There was no gender-related differences inside each school.

Attitudes toward learning

In general, UTPB students had a better attitude toward learning than UH students. There was no difference between all majors or teachers and non-teachers at UTPB. Young students from UTPB were more positive in their attitude toward learning. There was no difference between the younger and older students at UTPB. UTPB female students had a better attitude toward learning than UH female students, but there was no difference between male students in both schools as well as no difference between genders inside each school.

Attitudes toward a Computer Literacy course

In general, UTPB students were more positive than UH students in their attitudes toward the Computer Literacy course. There was no difference between the majors or teachers and non-teachers (UTPB). UH younger students were more positive toward the course than UTPB younger students. There was no difference between younger and older students at UTPB. UTPB female students were more positive toward the course than UH female students, whereas the attitudes of male students in both campuses did not differ. Inside the schools there was no significant difference between the genders.

Question by question comparisons

When comparing the schools there were six questions in which significant differences were observed: 5, 11, 12, 14, 15, 22 (questions related to the computer as a tool, attitude toward learning and the Computer Literacy course). In all cases UTPB students had more positive attitude than UH students which matches the results presented above. For the five groups ofacademic majors (combined from both schools), the only significant differences occurred for questions 1 and 8. Business majors and prospective teachers were the least frustrated by computers, whereas natural science majors and undecided students were the most frustrated. Undecided students (followed by students from arts and humanities) were most likely to believe that computers will enslave people, the business majors and prospective teachers were least likely to believe it. The only gender-related differences (combined from both schools) occurred for questions 9 and 22. Female students believed that computers save time and expected to use them more often in the future. The largest number of significant differences occurred between younger and older students. The only case when younger students were more positive was in their belief that everybody is capable of using computers (question 6). For questions 3, 11, 14, 15, 20 and 22 (related to the need for computers, attitude toward learning and the course) older students are more positive than younger students.

Conclusions

The results of this study must be considered tentative because of the small sample involved. The results, however, do suggest that there is no significant difference between the prospective teachers and other students' attitudes toward computers. There may be significant differences when considering age and gender. There also seem to be substantial differences between students at UTPB and UH. The last result supports Connell's (1991) suggestion that attitude toward computers may be more site specific than generalizable. We do not want to present any additional generalization, as this was only a pilot study and additional data collection is necessary. Based on the results presented above, and the response from the students and colleagues we are in the process of redesigning our survey. The new survey will be administered in the Spring 1994 semester.

Acknowledgements

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Appendix 1

Indicate the extent to which you agree or disagree withthe statements listed bellow. Be sure to respond to every statement.

1. I am frustrated by computers.
2. My experience in working with computers is negative.
3. Many times in the past I had a need for a computer but didn't know how to use it.
4. I feel uncomfortable each time I start to work with computers.
5. I will use the computer after college.
6. Only smart people use computers.
7. I think that I will never be successful working with computers.
8. I am afraid that one day computers will take over and enslave people.
9. I think that computers do not save me time.
10. One cannot learn about computers by her/himself.
11. I am interested in learning more about computers.
12. Computer Literacy courses should be a requirement for all high school students.
13. Sufficient instructions should be provided when using computers.
14. This course will make me appreciate the use of computers in my field.
15. I am always ready to learn new things.
16. I feel uncomfortable when I see that other students know more about computers than I do.
17. I think that the computer is a tool that I will never need to use.
18. This course will help me in other courses where computers are used.
19. This course will have a big impact on my choice of courses I will take next semester.
20. Using computers should be a part of all courses.
21. One can get addicted to the computer just as one can get addicted to drugs.
22. I expect to use computers much more than I have before.
23. Taking this course will help me overcome my frustration with computers.
24. I think that the role of computers in daily live will increase in the next ten years.

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Technology in a Teacher Education Program: A Qualitative Study

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It was Saturday; the campus was deserted. As I unlocked the building, I noticed that it was like a mausoleum - a contrast to the normally crowded halls on a week day. The elevator promptly arrived, another indication that few were in the building. I proceeded to my office on the third floor of Harrington Tower, the eight story building that housed most of the offices and some of the classrooms for the College of Education. I noticed that there were little yellow sticky notes on the posts above the locked doors. Some of them said "LAN" and others read "Reconfigure. New Board."

As I rounded the corner, I saw some doors were standing open; there was activity at my end of the hall. Three men with wires and connectors for computers dangling from their shoulders and arms were proceeding from office to office down the hall. They had been in my office the day before to install "WordPerfect Office" on our IBM. They explained that they were checking the computers to see if the appropriate software had been installed to hook up to the new electronic mail system for the College of Education. The third floor would be the last floor to initiate the new technology. The young men said they were running into problems; thus, this would not be the last Saturday they worked to get the system up and running.

The following weekend, the total quality management team on communications met to discuss how faculty who had never used E-mail could be taught how to use the new system. This was not the first expression of anxiety over technology expressed by the faculty. The college had received close to two million dollars in a grant from the Texas Education Agency (TEA) that initiated the placement of computers in eight local schools, and in Texas A&M's and Prairie View A&M's colleges of education. Through the funding, seventy-six Macintosh computers and twenty-four IBM computers became available to faculty. There were voluntary training sessions on both the Macintosh and the IBM computers, but few faculty were able to take advantage of the training sessions.

The outcomes of the Texas Education Collaborative (TEC) are compatible with the goals of TEA and NCATE. Technology standards for teacher preparation not only include learning how to use technology but initiating foundations courses in computer technology that prepare future teachers to apply current instructional principles, research and appropriate assessment practices; demonstrate knowledge of uses of computers for problem solving, data collection, information management, communications, presentations, and decision making; design and develop student learning activities that integrate computing and technology for a variety of student grouping strategies and for diverse student populations; demonstrate knowledge of uses of multimedia, hypermedia, and telecommunications to support instruction; demonstrate knowledge of equity, ethical, legal, and human issues of computing and technology use as they relate to society. (ISTE Accreditation Committee, 1992).

With the initiation of the grant, many questions emerged. Do teacher educators see the relevance in including technology in teacher preparation? Do they understand the place that technology has in teacher preparation? What do teacher educators perceive is the utility of technology in education?

Computer technology in schools

The use of computer technology in society lends "authenticity" to using the same kinds of technology in the school classroom (Collins, 1991). To many in our society, making students technologically proficient is the duty of schools in preparing students for today's society (David, 1991) because technology is the wave of the future. The U.S. Department of Labor's *What Work Requires of Schools*, 1991, p. 13, says of technology: "Technology today is everywhere, demanding high levels of competence in selecting and using appropriate technology, visualizing operations, using technology to monitor tasks, and maintaining and trouble shooting complex equipment."

Technology can provide schools with the traditional information-transmission model or the constructivist model. The way that technology is used in the classroom will impact our society and the way that schools function. It includes how teachers teach and how learners learn (Newman, 1992). "Many calls for the reform and restructuring of public education have featured technology as a centerpiece" (Butzin, 1992, p. 330). The focus of discussion becomes how and why computer technology is *necessary* to schools. Computer technology can be used to promote the status quo in education (Callister & Dunne, 1992) or can impact the restructuring of the school environment (Solomon, 1992).

Traditional schools focus on the acquisition of knowledge and low-level skills through the transfer of knowledge from the teacher to the student. The restructured model emphasizes the learner's engagement in the educational process. Technology is espoused to be the means by which schools can create an environment that is making the shift to active engagement in the learning process through risk taking, collaborative learning, and problem solving by the learners (Sheingold, 1991). Furthermore, Solomon, 1992, claims that educators of teachers need to model the use of technology through teacher training and access to technology.

This is the premise driving the emphasis on technology by the Texas Education Collaborative.

Methodology

A survey initiated through the TEC revealed that teachers see little connection between the academic improvement of their students and their efforts to learn how to prepare and use multimedia presentations in their classrooms. The results of the survey made me wonder if college faculty that received computers are approaching technology with the same attitudes. Using an ethnographic approach to find out the faculties' perceptions seems more appropriate than finding the answers through a survey.

Spradley's (1979) techniques for interviewing were used during the interviews. Participants included five faculty members representing a variety of interests and subject areas. To clarify the participant's knowledge and expertise in the use of computers, they were asked to edscribe how they used a computer.

Using Denzin's (1989) recommendations for capturing and bracketing, the interviews revealed several interesting ideas. Conceptions about the pedagogical use of technology and perceptions about the place of technology in the schools of a democratic society from the view of college faculty were topics that emerged.

Results

The results presented in this section related to participants' levels of use, attitudes toward computer use in education, and philosophical issues.

Participants' levels of use

Colleen, an early childhood educator who is an avid constructivist, says of computers and their use, "A computer sitting on your desk is a value statement. What does it mean? Also, [the way] you use the computer is a value statement." All of the informants use computers but they were at different levels of expertise in their use.

For example, John, an elementary science educator, is familiar with many applications in technology. He says:

> Obviously, everybody isn't where I am. (smile) I can't imagine not having a computer as a word processor and for record keeping. Record keeping and writing: that kind of technology is important. It's more than that - It's CD-ROM's and laser disks. For example, I'm familiar with Windows on Science, Optical Data's laser disk. First thing in the morning, both at home and the office, I use the computer. I write my plans and lesson notes and activities for the students to use. I use the computer a lot for that and for record keeping. I hook up into low technology bulletin boards with Prodigy and get the weather and activities off of Nova. Occasionally, about 20% of the time, I use some sort of technology to present the lesson.

John's variety of experiences with technology is not shared by other participants. Computers do not make a value statement in Ted's life, even though he uses them. He says, "I mean, I'm to some degree computer literate [but] it hasn't changed my life and hasn't improved my thought processes - that's been a result of literacy development, not development in the realm of computer literacy." Adolpho, a faculty member who just received a five hundred thousand dollar grant, explains that he "writes grants on [the computer]."

Colleen tells how she uses the computer:

> I don't use it for all the wonderful things that I could. Now [I use it] for a word processor and, of course, in the past, when I was doing quantitative things, I used it for statistical analysis. Of course the word processing can be used a lot related in qualitative research from unitizing to writing the research paper.

> [Technology, the computer,] has wonderful, wonderful possibilities. My thirteen year old son uses it for a lot of things; he makes visuals, graphics. And it's used for things like check book balancing.

Colleen, as well as all the participants, uses her computer for proposal writing and word processing.

Attitudes: Computer Use in Education

Participants express a wide variety of attitudes about the purpose of using computers and the relationship of computers to education. They realize that, despite problems with using technology, especially computers in the classroom, technology is becoming an important aspect of our society. Colleen describes some reasons for including technology in education:

> I do think that any resources, values, etc. anything that are parts of society have to be part of teacher education because we deal with society. Technology has a definite role in teacher education in that teacher education has to deal with all aspects of society. Technology has another role in that if there are things that can open up possibilities for methods and opportunities for the child, we need to use them.

Technology might not be an asset to education as Ted expresses:

> I don't know if it's really going to contribute to all around education. Proponents of technology say we can get students to take different perspectives - solve problems make sure that's going on. Solicit perspectives. We need a diverse, legitimate existence, instead of relying on computers. I know I'm the voice of technophobia in college but there are serious questions that cloud its use. These [questions] are ignored because technology is synonymous with progress.

Colleen has thought about these same issues. She states that "it should not be the guiding force because it's a societal issue not focusing on the human being and teacher education." Reid, who is writing an article on teaching with technology with a colleague, does not "equate technology with computers." He defines technology as "any application of useful knowledge." He does not believe in putting the computer first. "That's being technocentered," he explains.

Those who perceive technology as an advantage for education describe computers and other hardware as just another pedagogical tool. John says, "Technology isn't the savior of education; it's teaching right and planning right; and part of that is using technology." For some, like John, it can be an attention getter:

> The entertainment factor is important - not slap stick stuff but to capture their attention in a different way than they are used to. I mean, different than what we use. If they could play Nintendo, in the classroom to learn, wouldn't that be great? Why shouldn't we have this available to motivate kids? It would be captivating.

Ted expresses philosophical problems with this idea:

> There may be kids that turn on to school because of computers, but we need to treat the symptom rather than the cause; it's not a good argument to embrace technology. School's are not a friendly place for a lot of students. It could be they pick up the vibes of racism. Kids of certain cultures don't do well - mostly due to the nonverbal [elements]. The real problem is: What are we doing structurally that's wrong? to make children hate school ? What have we done?

There is always the fear that computers will take the place of teachers just as technology has eliminated other jobs. Ted says, "The computer is replacing that standard authority figure. It has all the answers instead of helping stepping back." This issue is discussed by John but in a different manner, "I don't fear that [technology] will replace me; if teachers can be replaced by a book or some curriculum or technology, maybe they ought to be replaced."

Philosophical Issues

There is hesitation by the faulty in using computers in education. This is obvious when Reid complains, "It's been frustrating because we've tried to provide workshops but there are very few takers. We've had a couple of workshops, but almost no one signs up for them." Ted believes that technology is "structurally the same [as what's going on in schools now]. It's melded into the status quo - drill and practice." He expresses valid concerns about the use of technology in schools from a philosophical point of view:

> What movement [education has] made is directly threatened by computer technology. We've been getting away from 'I'm the teacher, dispenser of knowledge,' to 'I'm just a participant in the milieu of environment. Student and me working together.' It seems its a notable time when [both students and teachers are] needed and participate. We're working towards that. The computer is replacing that standard authority figure. Interaction will now be between [a] kid and [a] computer.

Ted is concerned that the influence of politics and economics in schools is "too direct, anything of educational value gets lost." He sees that "schools, for computer companies, are fantastic" but fears that the computer companies' interests are purely economical. He further explains his perception of the negative influence of politics on education:

> We have computer literacy campaigns in Texas that I'm not sure what it's for other than it seems to have utility for future employers such as key boarding, inputting data. It's a good skill. But computer literacy isn't as liberating as literacy is.

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> Think about Anderson's book, how he equated education and literacy with freedom - being able to read and coming to grips with liberty.

Colleen describes a discussion among educators in a teacher education research group formed to read and discuss moral and ethical issues. They read and discussed an article by Michael Apple on technology. "From his perspective, he wrote how it could serve to disempower women because it imposes certain jobs on that group," she explained. She further described the discussion:

> I do think if we aren't taking a critical perspective and if we don't analyze [use of technology], we might have problems. When we were reading this and in talking about it, three in the group brought up some interesting ideas. We started talking [about the creation of] computers and the nature of computers, and, I'm not belittling white men now, [but] your good old American men have come up with the thought of the computer plus it fits into the perspective of math and science, right and wrong answers. If other groups had come into power over these hundreds of years, there might have been something different than the computer. Tools come out of value structures.

Teacher Education and Technology

The preceding ideas about technology are valid concerns that should be confronted in teacher education. However, technology is being infused into the teacher education program and, in Texas by law, it is becoming an integral part of the pedagogy. When participants explained how they would teach or use technology in their classrooms, several ideas were expressed. Most participants believe we should use computers as a "methodological tool." Adolpho explained that the four basic skills in ESL are oral, listening skills, reading skills and writing skills. "Each skill [has a place] where technology can play a role," he explains, "There is a significant role in ESL for technology."

Colleen sees "lots of potential uses in child development. Interactive things could be developed - like in anthropology; there are lots of developmental kinds of things that could be done." But she warns:

> [Technology] shouldn't be the guiding force because it's a societal issue, not focusing on the human being. Teacher education needs a critical perspective that causes us to deal with the real thing and that deals with kids. [It's] not just technology but all kinds of bandwagon things. In teacher education we don't analyze the [implications]. [Technology]'s fine to be in teacher education as long as we're analyzing how we're using it and presenting it, or if we put certain groups in more powerful positions that others. [I] do think [teaching how to use technology] is a responsibility. I'm concerned with over infusion of technology. Any resources that provide children with more opportunity, we should expose [future educators] to including the critical massages and underlying values that go with it. When they make decisions about using technology, it has moral and ethical implications.

Ted is also concerned about teaching future educators the implications of using technology. He agrees that "computer technology should be available to students of education for what it can help them do to facilitate research and for getting familiar with software that might be out in the schools." But he believes that the philosophy behind the use of technology is what is most important:

> [Future educators] need to come to grips with what it means to be educated and then sort out for themselves the role of technology and how it tends to be catalyst for students. We've got to be able to bring [student teachers] to a level of intellectual confidence so that when they get their own classrooms, they can do what they should.

John believes that teachers can "create educational materials to get into a format the [their own students] can best learn in." He says that "when I start using E-mail, I'll have a student from last semester show me how to do it." He applies this idea to his own students' learning and use of technology:

> You need to grab up people by the hand and show [them how it works]. It almost has to be a mentor situation. Teachers in the schools will be teaching our students and us how to use technology. Maybe we have to [make] a special effort by sitting at the feet of someone else and learning from each other.

He believes that teacher educators need to model using technology as well as have their students practice using it. "I don't think it would go very far if they didn't do it. If they don't do it and just see me modeling it, they probably won't ever use it." In order to ensure use he says of his student in their field based experience, "I'll force them when they are out teaching to have prepared [lessons using technology]."

Adolpho says that, "We need to assess the educational needs of each learner [before we use technology]. We can't assume that all the students have the same linguistic needs." He believes that future educators need to be taught this in their classes.

Reid told about a hierarchical framework for teaching with technology: familiarization, utilization, integration, orientation, and evolution. He explained that learners, whether they are teachers, teacher educators, or future teacher, need to start at step 1 (familiarization) and work their way up the ladder. He described the process as follows:

> You can take any experience such as [learning] Claris Works, [using] cooperative learning or some other great idea. The first step is to get familiar with it. When at a workshop, all [teachers] do is get familiar with it. Then they try it out back in the classroom. That step is utilization. But often nothing else will come out of it. It becomes integrated when

> the teacher makes a commitment to it. For example, take chalkboards, when teachers use them so much that if they take it away it's not business as usual, that's integration. This can apply to taking away a black board, flip chart, cooperative learning, or computers. This step is so important. The fourth step is reorientation. Actually, it is the next major phase in an educator's life where you start thinking about [the implications of what you are doing]. It's like restructuring; the teacher is open to new ideas and scraps the old. It is reflective practice and a willingness to restructure. They reconceptualize their place and role in the classroom; they have a different attitude. The last step is evolution. It is when they continually adapt to change.

Reid applies the above explanation to when he describes the role of technology in teacher education:

> If we just introduce the spread sheet, data bases, or word processing and never go any further than introducing [the mechanics], students will be just at the first step. At the utilization level, maybe I'm using technology to teach something but not asking them to use it - no activities that they do such as spread sheets. Actually using it [is necessary to integration]. Reorientation is parallel to what Donna Wiseman and Dr. Stallings are about in how teacher education should be restructured.

Implications of the Study

The variety of responses from the participants might be because they are not beyond the utilization level. However, it interesting that educational reformers such as John Goodlad, Theodore Sizer, and William Glasser rarely, if ever, mention technology in their writings. Further research is needed to determine if those in higher education reflect on the implications of using and promoting technology in public schools.

It is commendable if a teacher education institution in the process of infusing technology into its program develops a unified philosophy before initiating such a program. The faculty members at this university have visions of technology that conflict with each other; they do not have a common perception of the place of technology in a teacher education program.

Reid gave an analogy comparing this conflict with that of a symphony orchestra:

> It's like the professional violinist or the pianist or the drummer; they play good by themselves but what if you want to have a symphony. If the pianist leads, he says his instrument is the best and the same goes for the violinist or the drummer. They want to be up front. We need a conductor.

The faculty of a college of education should consider if its involvement with technology will disempower or empower our children. They also need to determine how they will infuse technology into their teacher preparation program. It is our responsibility to prepare future educators to consider the results of using technology as a pedagogical tool and to use that tool to promote equity in education.

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Interactive Video Simulations: Factors Related to Promoting Teacher Effectiveness

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The use and effectiveness of computer driven simulations as a pedagogic technique for providing students with realistic experiences in which they can apply problem solving and decision making skills has been well documented. Simulated classroom experiences have similarly been used to allow preservice teachers to confront some of the tasks and situations they will face in the actual classroom environment. Cruikshank (1986) has suggested that "concrete-real" instructional methods such as student teaching could be made more effective if they were preceded by "concrete-modeled" experiences such as simulations. Research by Smith (1986) and Strang, Kauffman, Badt, Murphy & Loper (1987) has emphasized the effectiveness of realistic classroom simulations.

Recently, the development of interactive video models of computer based instruction have made possible the design of fairly sophisticated, interactive learning tools (Dalton, 1986; Dalton and Hannafin, 1987). It is widely believed that the use of interactive videodisc simulation in teacher training can provide instruction in a number of important skill areas while in a controlled environment. Interactive video makes it possible to increase the amount of active simulation teachers can experience while providing for greater control over the nature of that experience. While it is generally believed that an increase in the relative degree of situational realism will automatically result in a corresponding increase in learning, it is not clear what aspects of the situation are responsible for promoting learning.

To date there has been limited application of this technology in the training of teachers. Those studies which have been reported, have produced positive results (Volker, Gehler, Howlett and Twetten, 1986; Goldman and Barron, 1990). The application of interactive video to the presentation of classroom management skills, and in particular, to classroom discipline was addressed in a study by Berry (1992). This study compared groups of preservice and inservice teachers who received either interactive video simulations or text-based scripts of the simulations. Results indicated that the interactive video simulations were significantly more effective for the preserviceteacher group. Data revealed that interactive video simulations produced substantially different decisions than did text-based materials. Specific reasons or factors contributing to the increased effectiveness were not apparent. It is not clear whether participants were using visual, contextual, experiential, or emotional cues in making their decisions. The present study constitutes a further, more in-depth, investigation of those aspects of the interactive video simulations which are responsible for increased learner performance.

Purpose of the Study

The purpose of this study was to identify those factors which are responsible for improved performance by preservice teachers interacting with an interactive videodisc simulation. Secondarily, the intent was to compare the factors identified by preservice teachers with those identified by inservice teachers in decision making related to

Table 1
Distribution of Subjects Across Experimental Groups and Performance Levels

	Experimental Group		
Performance Level	**Preservice**	**Inservice**	**Total N**
Highly Successful	16	21	37
Moderately Successful	22	19	41
Least Successful	31	13	44
Total N	69	53	122

classroom discipline strategies. The following research questions were formulated:

1. What factors or aspects of the interactive video simulation are identified by preservice and inservice teachers as being useful in making discipline related decisions?
2. To what degree are these factors similar or dissimilar between preservice and inservice groups?
3. Are the factors which are identified similar among those preservice and inservice teachers who are most successful in decision making and those who are less successful?

Method

Participants in the study were sixty-nine preservice teachers enrolled in teacher development methods courses and fifty-three practicing, inservice teachers. None of the preservice teachers had any formal classroom teaching experience and their ages ranged from twenty-two to fourty-three, with the mean age approximately twenty five. The mean number of years teaching experience of the inservice group was ten years, with a mean age of approximately thirty-seven. All participants were volunteers.

The materials employed in this study were the interactive video simulations used by Berry (1992). These simulations were based upon and used the videodisc program *Critical Incidents in Discipline* developed at Kent State University by Evans, Cupp and Kinsvatter (1987). This interactive videodisc program was designed to present three classroom discipline situations from the viewpoint of the classroom teacher. Teachers or preservice teachers may then interact with the various situations, making what they feel are the appropriate teacher's decisions to each of the simulated discipline problems. As with other interactive video simulations, students are branched through a variety of video sequences which present the probable consequences of their decisions. Resolution is generally dependent upon the teacher's ability to defuse and discuss the problem rather than to become defensive or authoritarian. The total time required to complete the three incidents was approximately twenty minutes. Each subject worked individually with the program and was encouraged to take as much time as necessary to think through their response.

The simulation was programmed in HyperCard and was presented via an Apple Macintosh SE computer linked to a Pioneer LD-V4400 videodisc player. A student recordkeeping subroutine was incorporated to track user performance at each interaction.

Based upon a subject's total decision score, each group was divided into three performance levels using +/- one standard deviation as the criteria. These performance groups were designated as : Highly Successful, Moderately Successful and Least Successful, resulting in a 2x3 matrix of experimental groups (See Table 1).

Analysis of variance procedures were employed to confirm the statistical independence of all groups. Upon completion of the simulation, each subject was interviewed using a standard, twenty-five item interview form which first posed open-ended questions regarding what information was most helpful in making their decisions. Later questions became more focused and queried the subjects about specific aspects of the interactive video simulations. Data gathered was evaluated and categorized for each subject within each level of performance, resulting in a comprehensive data profile for each person.

Results

Analysis of the interview form data for each performance level and across both experimental groups indicated that ten categories of information were used in resolving the simulations, These included:

1. Experience: A factor generally identified by inservice teachers, based on prior examples of the discipline problem.
2. Intuition: A sense of what is the *right* decision, not based on facts in the situation.
3. Emotional: A response or evaluation based on a like or dislike of the student in the scenario.
4. Authoritarian: A response based on a *I am the teacher and I am right* approach.
5. Conceptual Strategy: Responses based on prior strategies, either taught or learned from experience.

7. Aspects of the Situation-Body Language: Visual information drawn from the student in the video presentation.
8. Aspects of the Situation-Voice: Verbal information from the student presented in the video presentation.
9. Aspects of the Situation-Classroom Environment: Visual or verbal information drawn from other students and the classroom environment.
10. Contextual Information (Nonobservable): Feelings about the classroom or encounter with the student which do not relate to specific, observable activities i.e., A sense of tension in the room.

The Frequencies of subject references to these information/response categories were tabulated for each performance level and across both groups of professionals. Statistical analysis via the Kruskal-Wallis Analysis of Variance procedure was used to indicate where significant differences occurred (Table 2).

Analysis of the data indicated that inservice teachers were, on the whole more successful in resolving classroom discipline problems, a finding that could be expected. Further analysis, however, suggested that across the different performance levels, different factors within the interactive simulation were being used to base decisions. Among more successful inservice teachers, the conceptual strategty factor was most important, whereas more successful preservice teachers relied on situational and intuitive factors more. Less successful inservice teachers employed emotional and authoritarian strategies most and the less successful preservice subjects relied upon *canned* strategies and emotional or authoritarian evaluations of the situation. It is important to notice that the ability to *read* situational factors in the video scenario such as body language, verbal dialogue, and classmate reactions were important aspects of the more successful preservice teachers decision making strategies.

Table 2
Factors Employed in Making Discipline Related Decisions, Frequencies, Percents and Kruskal-Wallis H by Experimental Groups

	Preservice				**Inservice**			
Factor Employed	**High Success**	**Moderate Success**	**Least Success**	**H**	**High Success**	**Moderate Success**	**Least Success**	**H**
Experience	6(9%)	5(7%)	4(6%)	3.40	15(28%)	8(15%)	7(13%)	3.48
Intuition	7(10%)	3(4%)	3(4%)	6.99*	13(25%)	6(11%)	5(9%)	3.95
Emotional	5(7%)	6(9%)	15(22%)	6.01*	2(4%)	3(6%)	7(13%)	9.62**
Authoritarian	4(6%)	8(12%)	16(23%)	7.00*	3(6%)	5(9%)	9(17%)	9.60**
Conceptual Strategy	12(17%)	11(16%)	13(19%)	3.89	14(26%)	4(8%)	6(11%)	8.22*
"Canned"Response	2(3%)	3(4%)	8(12%)	6.03*	0(0%)	1(2%)	3(6%)	6.23*
Situational-Body Language	13(19%)	7(10%)	9(13%)	13.00**	6(11%)	4(8%)	3(6%)	.32
Situational-voice	9(13%)	4(6%)	4(6%)	11.24**	4(8%)	2(4%)	2(4%)	.566
Situational Environment	12(17%)	8(12%)	8(12%)	6.73*	9(17%)	5(9%)	3(6%)	1.86
Contextual-(nonobservable)	9(13%)	5(7%)	8(12%)	5.68	8(15%)	2(4%)	3(6%)	4.04

*p<.05 **p<.01

Discussion

While it was expected that inservice teachers would rely on experiential and intuitional factors most, this was not the case. Rather, inservice teachers relied most on strategies to successfully resolve discipline situations. Less successful, inservice teachers resorted to authoritarian solutions and emotional responses, possibly because of a lack of strategy building. It is important to note, that inservice teachers did not utilize visual, verbal or other situational aspects of the interactive video presentation upon which to base decisions. This may be attributed to the fact that experienced teachers have *seen it all before*, and do not need to use other situational cues. Possibly their strategies have been developed previously, in actual classroom experiences.

Preservice teachers did rely heavily on cues presented in the interactive video presentation to make successful decisions. This may imply that the provision of such simulated experiences replaces actual classroom experience and strategy building activities by giving preservice students actual data with which they can draw conclusions and build strategies. The videodisc simulation could, in this way, supplant the longer term inservice experiences and give newer teachers a series of *quick* discipline related interactions. This also suggests that it may be very important to teach or discuss appropriate strategies in conjunction with the interactive video presentation to help build the links between specific, yet abstract, strategies and the more concrete, observable classroom cues.

Conclusions

In answer to the three research questions, it can be concluded that:

1. A number of factors or aspects of the environment are used by teachers in making discipline related decisions in the classroom. Primary of these are: experience, intuition, emotional factors, authoritarian responses, conceptual strategies, "canned" responses, situational factors such as body language, verbal dialogue, and environment as well as nonobservable contextual factors. Specific factors are associated with decision making which resolves discipline situations and other appear to be related to the decisions of less successful classroom managers.
2. The factors differ between inservice and preservice teachers in that inservice teachers emphasize strategies which resolve problems. Preservice teachers, however, appear to extract useful cues from the classroom environment and the interactions with students when they make effective decisions. Apparently they rely on more concrete data since strategies have not yet been learned.
3. The most successful and the least successful teachers or preservice teachers appear to use very different factors in their decision making, It is highly possible that this is the primary reason for poor performance in classroom management.

It is clear, while preservice teachers do not seem to resemble experienced inservice teachers, that they can use situational factors in dealing with discipline problems. This may only be a temporary solution until effective strategies are developed. For this reason it would seem important to embed and explicate conceptual strategies into any interactive simulations developed for this purpose as well as in the use of existing simulations in teaching methods courses.

Additional research needs to focus on developing an understanding of how experienced teachers analyze discipline situations and apply strategies so as to enable preservice teachers to model the appropriate techniques. Both of these needs are predicated on a more detailed knowledge of the cognitive processes which are employed by both inservice, experienced teachers and by preservice or beginning teachers in analyzing a given situation.

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Did Video Really Work? An Analysis of Student Teachers' Perceptions

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The beginning of each student teaching semester is exciting yet stressful for many preservice teachers. These student teachers raise many legitimate questions concerning their pending experiences in the practicum, questions such as, Will my cooperating teacher like me? When do I assume full-time instructional responsibilities? What happens after my supervisor observes me teaching ? How will my supervisor grade me?

At LaSalle University, these issues had been addressed primarily through direct oral communication coupled with a modest document which sketched some general principles and guidelines. Recognizing that this approach was incomplete and inadequate, we developed a more comprehensive multimodal approach which included not only a revised handbook and a more extensive orientation and consultation seminar throughout the student teaching experience, but also two program-specific instructional videos. *The Professional Year: An Introduction to Student Teaching in Elementary and Special Education (ESE)* and *The Professional Semester: An Introduction to Student Teaching in Secondary Education (SE)* were completed in 1992 and first used during the 1992-1993 academic year. Each video was designed to orient student teachers in the two respective programs to policies and procedures required of them during the student teaching practicum. Specifically, each twenty minute video presented a program director guiding a small group of student teachers through simulated roundtable discussions focusing on the department's educational philosophies and policies. Each video also included two vignettes which dramatized critical issues about the student teaching experience: first, establishing student and cooperating teacher rapport; and second, demonstrating the group dynamics of post-instructional conferencing (Bednar, Ryan and Sweeder, 1993a).

This present study is the third part of an on-going investigation of the value of video as a preservice teaching tool. The initial study presented and critiqued the processes used to produce the videos (Bednar, et al , 1993a); whereas, the second study evaluated the cooperating teachers' responses to the use of videos as a communication tool between the university and individual schools (Bednar, Ryan and Sweeder, 1993b). In contrast, the purpose of this study is to explore student teachers' perceptions of the videos' value as an advance organizer to help them understand the parameters of the student teaching experience. In addition, this study analyzed, first, whether student teachers would identify specific elements of the video as potentially helpful; and second, the degree to which the student teachers felt that specific aspects of the video actually helped them during student teaching.

Participants and procedures

In September 1993, seventy-two Elementary and Special Education student teachers were shown the ESE version of the video during their four day orientation to their student teaching year. The video was shown at the beginning of the first orientation session and was followed by a presentation of policies and procedures. At the close of the two and one-half hour session, student teachers were asked to respond to the video by completing the authors' designed survey which targeted the following areas:

- overall impression of the value of the video.
- specific segments of the video which they felt were most beneficial.
- suggestions for future video topics.

After teaching for six weeks, the students again responded to the same set of questions which, now framed in the past tense, attempted to reveal the degree to which they felt the video actually did facilitate their transition into their new roles as student teachers.

Data collected was analyzed using a series of rereadings based upon constant comparative analysis (Glaser and Strauss, 1967). Surveys were read and analyzed separately by each author to identify student " thought units" that pertained directly to the targeted areas. A thought unit is defined here as a single concise statement. For example, "informative," "good," "appropriate set induction," "a better understanding," and "It was neat to see people that we knew going through the same thing[s] as we are and knowing that they *made it!*" would be considered separate thought units. As shown in Figure 1, the thought units were categorized according to the authors' generated rating scale.

Discussion about each thought unit's rating ensued until 100% agreement was established.

Results

Data on both initial impressions and lasting impressions was gathered.

Initial impressions: Before entering the field

Sixty of the seventy-two student teachers survey responses were examined quantitatively and qualitatively. Of those responding, fifty-five were female and five were male. The majority of the students were twenty-one years of age, while there were eleven twenty-year-olds and one forty-four year old.

Seventy-six percent indicated that their overall impression of the video's value was above average to excellent. Ninety-six percent of the students indicated that their overall impression of the video was average to excellent in addressing their initial concerns about student teaching (see Figure 2).

Based upon our reflective analysis of the student teachers' initial impressions of the video, we identified specific reasons why the student teachers felt the video was beneficial:

Rank	Classification Descriptor	Thought Unit Responses
1	Poor	No Response
2	Below Average	"Would have been more informative if was less acted out"; "Seemed as if was rehearsed"
3	Average	"Pretty good overview"; "Gave a broad view"
4	Above Average	"It was well-presented, helpful"; "Gave me an idea of what to expect"
5	Excellent	"Very informative"; "It was very well done and helpful"

Figure 1. Thought unit classification scale.

- The video provided procedural information.
  Examples:
  It gave insight into the kinds of things supervisors expect to see from you and what occurs during the conferencing.
  It provided a good idea of what [a] meeting should be like, of what to expect.
- The video was helpful in underscoring affective concerns.
  Examples:
  It was a good video — clear in addressing fears about student teaching.
  It relieved some of my fears about what to expect.
  It can help me to stay calm and not be overwhelmed by a situation or a problem that can arise.
- The video was beneficial in addressing communication issues.
  Examples:
  It will help me keep the lines of communication open.
  It will help me to understand that you have to approach the [cooperating] teacher at the right time or ask her to set up a time.

Four percent, however, indicated that their initial impression was below average. For example, one student wrote "[The video] seemed as if it was rehearsed," while another observed "I think the video would be more informative if it was less acted out."

In addition to general impressions, student teachers targeted specific elements of the video as being potentially the most helpful to them when they entered their field placements: the vignette which addresses post-instructional conferencing (61%); the roundtable discussion where the student teachers portrayed in the video reviewed philosophy, policies and procedures (21%); and the vignette dramatizing communication between the cooperating teacher and the student teacher (18%).

Lasting impressions:
After one month in the field

We were curious to see whether the student teachers' initial perceptions and feelings regarding specific aspects of the video remained consistent during the semester when they again reflected upon its value. Their responses to the follow-up survey revealed, after four weeks of student teaching experience, that the conferencing vignette continued to be the video's most valuable aspect (44% positive response). Thirty-eight percent indicated that the vignette illustrating communication was the most valuable;

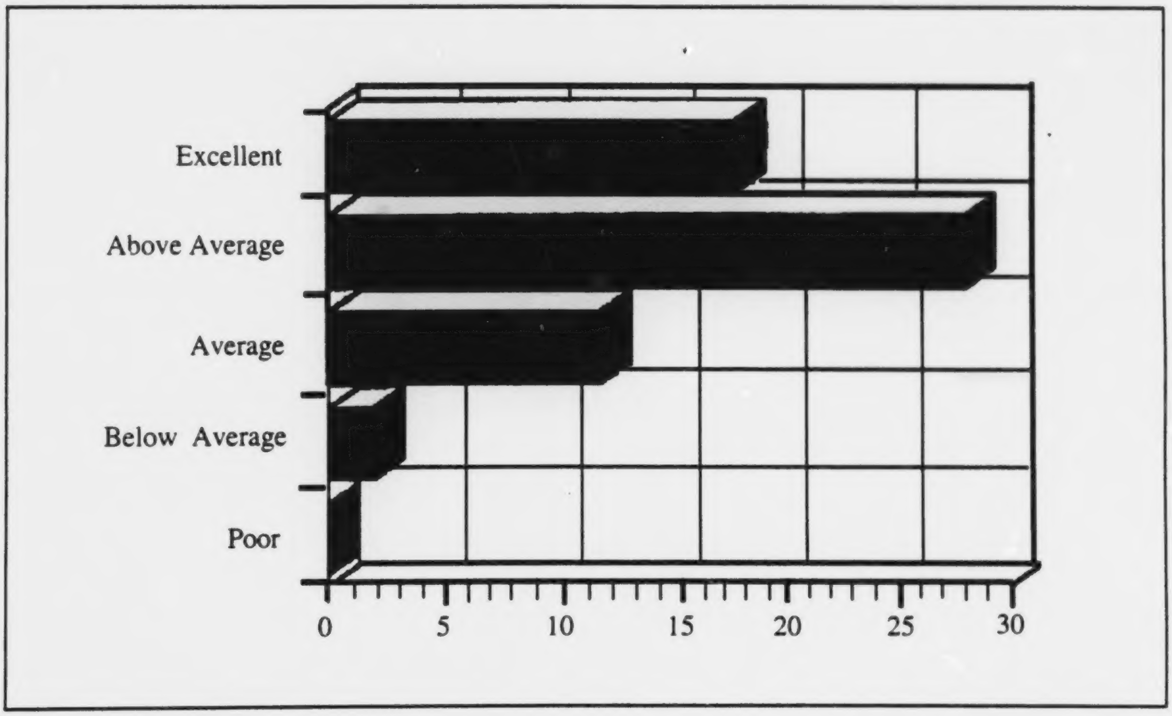

Figure 2. Student teachers' overall impressions of video.

whereas, eighteen percent reported that the roundtable component continued to have a lasting value (see Figure 3).

When asked to suggest future topics for videos to be used as part of the student teaching program, students indicated a desire to see a developmental video that would show a student teacher in the classroom performing authentic tasks over the span of the student teaching experience. "A student teacher in the classroom throughout the placement. Maybe five minutes a week as the weeks progress." In addition, there was a marked interest in seeing student teachers deal with issues related to discipline and classroom management. "Maybe a video showing examples of a discipline problem and how to solve it by using your own method so that the students don't think you are softer than the co-op [cooperating teacher]." A few students recommended developing videos that would address time management and that would treat specific instructional methods related to mentally and physically handicapped learners.

Discussion

Philosophically, the Department of Education at LaSalle University believes that learners should be provided with a number of ways to process information. This belief supports our recent efforts to provide our student teachers with a variety of ways to understand their upcoming student teaching practicum. Using almost exclusively printed materials and some direct instruction, past orientations addressed student teachers as if they were all left brained learners; this approach generally overlooked those who learn best through multimodal dimensions (Williams, 1983). By including a revised handbook, more extended interactive discussions, role playing activities, and a video, we now try to accommodate a variety of learning needs. This study focused on the value of using a video as an orientation tool.

The results indicate that the video was helpful for two interrelated reasons. First, because it presented departmental policies and procedures systematically and coherently, the video addressed many questions that the student teachers, watching it for the first time, brought with them to the orientation. Second, the dialogue between the program director and the "student teacher actors" during the roundtable discussion in the video clearly revealed that all student teachers approach the practicum with questions, anxiety, and uncertainty. As one student teacher noted on the survey response: " It was helpful to see other student teachers with the same questions."

The roundtable discussion, therefore, not only imparted

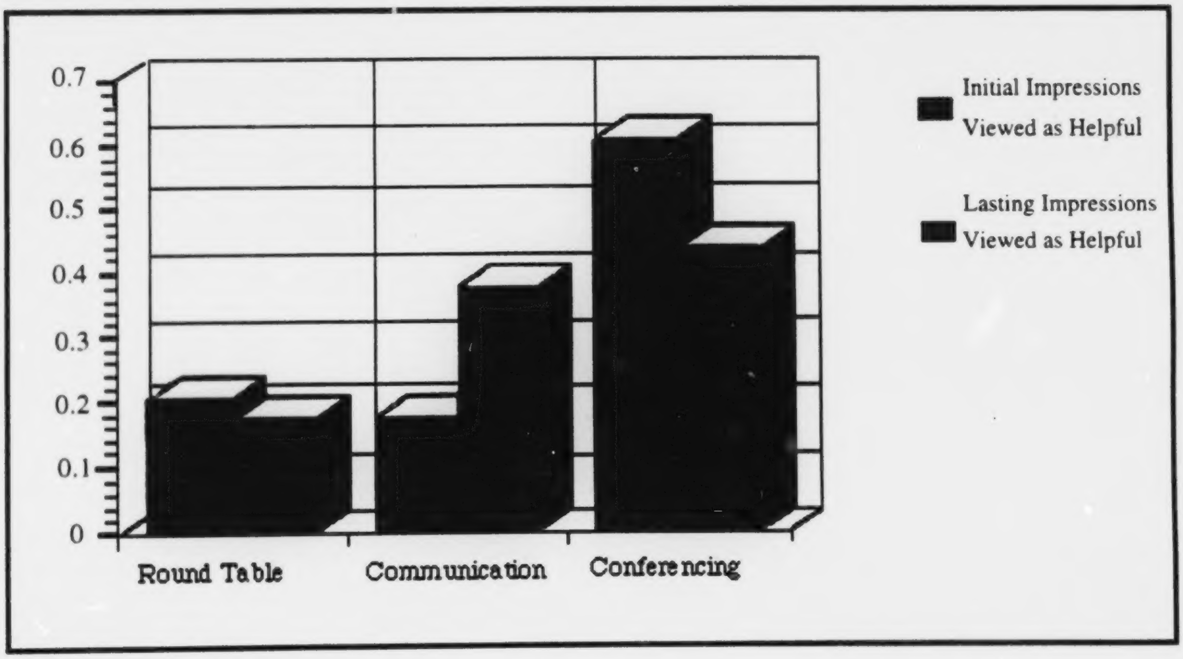

Figure 3. Initial versus lasting impressions of the video.

information and procedures, but, in dramatizing student teachers' concerns and queries, it established an immediate bond between the student teachers about to begin the practicum and those in the video. This bond was especially underscored by one student teacher who remarked that " The student questions [in the video were helpful] because some of them were my own. Also, student comments helped because they [the student teachers in the video] know where we are coming from."

When the student teachers first saw the video, they believed that the conferencing vignette was the most helpful. Their comments revealed that they were most uncertain about this aspect of the upcoming field experience, e.g., "meeting the supervisor and the co-op for discussion because now I see how it works" and "The conference with the supervisor was most helpful because I had no idea what to expect from it." In reviewing our preservice program, we realize that although we formally and informally engage our preservice students in forms of conferencing as part of class assignments, we do not address student teaching post-instructional conferencing with the university professor and the cooperating teacher. Seeing a vignette which demonstrates not only the cognitive aspects of a conference but also hints at the affective issues and the physical layout of such a conference permitted the student teachers to have a bird's-eye view heretofore denied them.

Did the student teachers find specific segments of the video helpful after they were engaged in the field experiences? Their responses indicated that this was so. Student comments attested that the conferencing segment continued to have the most value, e.g., "The co-op and supervisor conferences. It made everything more realistic," "How the supervisor can help mediate with the co-op" and "The video helped to give me an idea of what the conference with my supervisor and co-op would be like." Although their experiences in the field tempered their initial assessment of the conferencing, the student teachers still cited it as valuable. Their initial anxieties may have been mollified. Moreover, at the very least, this vignette depicted what a potential conference could look like.

During the orientation viewing, seventeen percent of the student teachers felt that the communication vignette was helpful. After they entered their field placements and needed to utilize some of the principles suggested in the video, thirty-eight percent felt this segment was helpful. One student teacher commented that the vignette was authentic and that she did see "how busy my co-op can be, and to be considerate of her time," while another concurred with " [The part of the video that was helpful was the part] dealing with co-op because I knew when or when not to approach her."

Conclusion

The student teaching practicum is the capstone of any teacher education program for it is here that the students demonstrate mastery of pedagogical principles as these principles guide communication, planning, instruction, management, and evaluation. To ensure that they understand the framework for operationalizing pedagogical skills in these contexts, it is critical that student teachers be sufficiently oriented to the procedures and requirements of the practicum from the very beginning. It is likewise important for them to know that the university supervisor and the cooperating teacher recognize the students' fears, doubts, and anxieties that invariably surface before and during the student teaching experience.

We have found that a multimodal orientation — with a program specific video as the centerpiece — is markedly more effective than printed material and oral commentary alone. In addition to meeting various learning styles, this multimodal approach, in utilizing both iconic and abstract modes of communication, enhances overall clarity and increases the probability that the information imparted by the video and the handbook will be understood and retained longer (Heinich, Molenda and Russell, 1993).

While the student teachers overwhelmingly stated immediately after viewing the video that it was helpful in allaying anxieties and in presenting departmental policies and procedures, their assessment of various components of the video changed after one month of teaching. Moreover, their experiences in the classroom prompted them to identify other areas, not addressed in the video, that might be included in future video productions. These student suggestions undoubtedly should be considered for inclusion in future videos. Nevertheless, this study verifies that video itself can be utilized as a central component of a comprehensive orientation program.

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Using Computer Networks to Study Computer Literacy

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The development of global computer networks has given researchers the means for rapid communication of ideas. It broadens the scope of research to a point that allows it to be carried on from any place with a link into the network. It has also the potential of reducing time of just collecting and assembling data to a few weeks. Based on the earlier experience with using computer networks to collect the data (Mitchell & Paprzycki, 1993b) the authors decided to try to apply a similar approach to study the present state and future of computer literacy.

This paper will serve two ends: describe the methods used to gather the data (as well as certain possible pitfalls) and present preliminary results.

Computer Network Based Research

Starting in 1991, two authors of this paper (Mitchell & Paprzycki) have collaborated on research projects while separated by more than two thousand miles and communicating primarily using e–mail. This cooperation led to publication of three papers and two notes as well as to a number of conference presentations (Mitchell & Paprzycki 1992, 1993a, 1993b, Paprzycki & Mitchell 1992a and 1992b). In 1992 we received an inquiry from Duckett about the possibility of getting copies of the publications to assist him in his research. We found there were common goals in the research and agreed to combine projects into a collaborative work in the area of computer literacy.

During the school year 1992/93, we communicated exclusively through e–mail in order to develop a two-part survey. Based on earlier experience we have developed a practical way of preparing manuscripts. Essentially, one of the three authors would draft a part of the text and then send it to the others for comments. The next in line would make his own comments and send it to the third who, after making his improvements, would then return it tothe original drafter. This iterative process was then repeated until a satisfactory stage was reached.

Data Collection

There is a number of issues that need to be addressed when attempting to use computer networks to collect data. First, size of the survey — if the instrument is too long, then people will not be ready to spend the required time to answer all questions. This can not only reduce the number of returns but some of the returns may come back only partially filled–in. Feeling that it would take too long to complete the full instrument we had developed, we split it into two parts. In part one we requested people to declare if they wanted to participate in the second part of the survey. Those who affirmed participation were contacted individually.

The second issue is related to the distribution of the instrument and data collection. We decided to use electronic discussion groups to distribute the instrument. To eliminate confusion and anxiety, for all parties, when sending a survey to a large number of lists, we recommend the following procedures be used (for further technical details see Mitchell et. al. 1993):

1) subscribe to each list to be used,

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2) send your message with a note to the moderator about what you are trying to accomplish,
3) request that the responses will be send directly to you,
4) watch for you message to appear on the list,
5) wait a few days to see before you un–scribe from the list.

Methodological Issues

There exist important benefits of using computer networks to collect the data. First, a questionnaire can be distributed to a specific group of individuals in a short period of time. Second, returning lengthy questionnaires is also made easier. And finally, the process of assembling the data (e.g. into a database) can be easily automatized.

There is, however, a question: "will such an approach work as a research tool?" The basic problem that was observed, which is also inherent to all survey research, is the small rate of return (establishing the true ratio of responses to the total number of instruments sent is even more complicated by the fact that one individual may be a member of several lists and thus counted many times). Unfortunately there is almost no way to control this factor. The only possible solution that we see is to use a Delphi–type approach (Melton, 1997) which we have employed already in an earlier study (Mitchell & Paprzycki 1993b). After some time the survey's data is compiled and sent back to the lists that were used initially (and possibly to additional, sometimes newly created, lists) with a note that readers can contact the authors for copies of the survey report. This procedure can be repeated at certain intervals to increase the total number of responses collected as well as to study possible changes in the response patterns.

It has been suggested that using computer network based surveys is a "scatter–shot" approach and as such it is not a very wise approach. However, we would argue that if the survey is very specific in nature and is directed to groups likely to be subscribers to the lists used to distribute the survey, then it is not a "scatter–shot" survey.

It is also possible to argue that when conductingsurveys via networks, a portion of the sample population is eliminated. This is a valid comment; many groups cannot be effectively sampled through electronic lists because few members of those groups use lists. However, the validity of this criticism decreases as the number and diversity of people connected to the networks increases (notice the rapid growth of Compuserve and other commercial systems that provide users with access to the global computer networks). For a detailed discussion of the methodology-related issues see Mitchell et. al. (1993).

Computer Literacy

Previous research indicated that computer literacy means various things to different people (Duckett, 1992, 1993). To those not formally trained in computer science, it very often means the ability to use a computer to fill their needs. On the other hand, some computer science educators tenaciously hold on to the concept that to be computer literate you must be able to read and write programs written in one of the programming languages. To eliminate any possible conflict that might arise by using the term computer literacy, we elected, for the purpose of the survey, to use the following definition based on Duckett (1992):

To be computer literate a person would have comprehensive skills, knowledge and understanding of computers and their use as they relate to technical, ethical, social and educational issues of the day.

As each discipline of study has specialized requirements, a global definition can extend no further than stated above. It is therefore the responsibility of each discipline to define the extent of skills, the level of knowledge and understanding of the use of computers, to be determined by each discipline, within its sphere of influence (Duckett, 1993).

Research objectives

In conducting this study, we sought to further identify what states, provinces, and/or countries required teachers to be computer literate as a requirement for certification. We also wanted to identify components of a possible computer literacy course for prospective teachers. To achieve this goal, a two-part survey was developed. Part one was designed to collect specific information about computer literacy requirements in place for teachers upon entering practice as well as support provided by the colleges to satisfy these requirements. In part two we attempted to establish the components contained in the computer literacy requirements, how people value the importance of these components, and what they perceive computer literacy should consist of (contact the authors for a copy of the surveys).

Results of the survey

The results of this study are divided into two parts, computer literacy requirements and the nature of computer literacy education. As in our earlier study (Mitchell & Paprzycki 1993b), we found that most states do not require teachers to be computer literate. Only respondents from Brazil, Puerto Rico, and the states of Indiana, Mississippi, North Carolina, Tennessee, Utah, Wisconsin, and the District of Columbia indicated that computer literacy was a requirement for teacher certification. [We know from other sources that other states, such as California, also have computer-related requirements for certification.] The results also suggest that this area is of limited concern for future certification processes.

In part two of the study, we sought to examine the current emphasis placed on computer education and what respondents felt the preferred situation should be. Based on a chi–square analysis, there was a significant difference between the current and preferred situations for 26 of the 27 questions. These differences lead to the following conclusions:

1) Whenever possible, computers should be incorporated into the curriculum and students should be encouraged to develop the appropriate computer skills. This indicates that teachers need to have comparable skills and understand how the computer can be part of the curriculum.
2) Computer literacy should be a necessary part of the teacher certification process and should be included in pre–service course work.

Based on the responses, computer education courses for pre-service teachers should encompass:

A) a study of the relationship of computers and society, including a consideration for the ethical use of computer software (copying, piracy, etc.),
B) a study of common word processing, data base, spreadsheet, desktop publishing, graphics, and authoring software packages (but not programming languages!),
C) usage of computer networks and electronic mail,
D) usage of computer as part of the learning process, a means for measuring educational outcomes, and the administrative process,
E) means for evaluating hardware and software.

These results confirm also the need to redefine the term computer literacy from its original programming basis to a more user-defined basis.

Conclusions

As society changes so does the definition of what it means to be computer literate. The data has also indicated that a serious change in the teacher preparation as far as computer proficiency is concerned is necessary to meet the new perception of computer literacy. If teachers are to help their students better use computers in their daily lives, they (the teachers) have to be computer literate, and this means they should have the appropriate skills before entering the classroom.

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Effects of *QuickTime* Multimedia Tools on Writing Style and Content

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This research examines an exploratory use of computer-driven video multimedia and video combined with word processing in stimulating the overall quality of students' written compositions. Multimedia technology provides additional applications for computer technology and because of this it is developed and adopted usually with little practical or timely research on educational consequences. This paper reports research on one of the newest developments in real-time video.

Background

For the past two decades or so, educators have passionately focused on the preparation of teachers to learn and use computer technology both for their professional responsibilities and for enhancing the instruction and educational experience they deliver to students. Issues of computer literacy content, skills and knowledge over mere awareness, the role and value of programming, learning with a conceptual understanding over mere ritualized procedures and priorities in administrative leadership have all been debated and explored in educators' quest to realize the promise of technology. Educators hoped that with a computer as their talisman they could magically motivate students, manage instruction and manipulate their educational programs in ways never before dreamed.

In retrospect, it seems that the technology itself, although impressive in many ways compared with non-technological methods, was nevertheless a critical limitation. The speed was never quite fast enough, the memory was never enough, the display formats were never realistic enough, the various devices were never compatible enough, etc. Today, new developments in speed, memory, video, especially the style and quality of the user-interface (computing environment) and available software have all made significant advancements that can help teachers get closer to those technological and pedagogical ideals. However, the promise of improved results provided by the miracles of computer technology often seems more elusive than ever before. This is especially so today as technology advances faster than our ability to master its use.

Suhor (1989) made predictions about technological developments and computer applications in teaching English in this decade. Suhor predicted general computer applications in teaching writing composition. However, while also covering everything from calculating technologies and desktop publishing to critical thinking software and video developments, nothing of today's computerized real-time video movie clips commonly found on CD-ROM and videodisc was mentioned at all.

For many researchers, this late 80's insight may be considered very recent and close to the cutting edge of what should be a currently unfolding reality. In our technological lives however, while the late 80's might not be ancient history, insights were far short of the quickly changing world we actually experience. There is pressure on researchers to examine changes and so-called advancements in technologies with direct applications in education in a timely fashion. Today's multimedia has further exacerbated this problematic challenge and existing knowledge is clearly insufficient for making intelligent and informed decisions about how best to use most of the newest technological advancements.

There are really very few examples of recent literature on video specifically related to writing composition. Most involve videotape, a comparatively older technology, with very little on digitized software or laserdisc media. Gano (1987) discusses a wide variety of video-based multimedia technology. He focuses on technology available to the general public rather than on any educational applications. Nevertheless, this is still useful for educators interested in the use of multimedia even though Gano mentions writing only as another form of self-expression. He never addresses the use of video in writing composition.

Barr (1986) did employ video material in educational situations using film to motivate remedial students to read and write. There was no examination of the actual effect of the movies on the students other than the increased motivation to participate in reading/writing activities. Due to disruptive behavior, Barr recommends that video (film) not be employed in remedial classes until students adjust to the lab environment and demonstrate the ability to work independently. However, he also pointed out how video can provide a large variety of topics on which to write.

Maginnis (1987) casually mentions the successful use of captioned videos in writing activities. Referring mainly to captioned videos presented on videotape cassettes, he states that "summaries, critical reviews and story maps" (p. 3), as composition activities, are easily developed around video presentations. This, at least, describes the use of video as a kind of prompt to generate the content for writing. Kelly and Nolan (1987) used video tape to generate writing topics for both deaf and hearing students. The focus of the study, however, had nothing to do with the use of video itself and instead focused on technical differences between deaf and hearing students' writing methodologies. While they document an example of using video to prompt writing topics, it is yet another case where the effects of video on learning were not examined.

One of the newest developments in multimedia is *QuickTime* for Macintosh computers which is a real-time video presentation application (software) that can present synchronized sound and video clips from CD-ROM or disk. This tool is likely to prove quite useful in computer applications in many areas of education. However, there is virtually no research examining educational consequences of using QuickTime in different disciplines. Galbreath (1992) provides an article on video tools, including *QuickTime*, but did not include any reference to applications in teaching writing. He instead addresses technical characteristics of compression ratios, display and storage.

Now as we reach the end of the century multimedia is continuing to expand and develop rapidly. Still, research, critical reviews and innovative ideas on using multimedia in teaching, are seriously lacking. Halio (1993) has specifically addressed the need for research on the use of multimedia in teaching writing saying, "...it's time to pause and examine how writing changes when multimedia adds new complexity to the process and to the product." (p. 80). She questions the value of current uses of multimedia as a tool for writing and outlines a variety of concerns that need to be addressed. These concerns include how students must possess technological skills as well as the high-level linguistic and verbal fluency, traditionally part of good writing. Her notions for using technology in the writing process addressed primarily the inclusion of video by the student to tell the story rather than as a prompt to stimulate or guide the actual process and content of composition. Although she acknowledges increased enthusiasm from her students, she questions whether the actual content is indeed improved by multimedia or even worth the time and effort needed to master its use.

These concerns point out the need for timely research on the latest developments in multimedia. This study attempts to address this challenge by exploring the results of using the multimedia video tool, *QuickTime*, in writing composition activities.

Methodology

During the spring 1993 semester of a Midwestern university, in a Macintosh computer lab equipped with word processing and QuickTime, 73 computing students in six sections were asked to write a personal composition on a given topic. Two video clips that related to the writing topic were presented on-screen to subjects, superimposed on their word processing work areas. With a simple click of the mouse, the video movie clip can be played in a small window which appears on the screen. The video subject matter, stored on CD-ROM, included a serious clip of approximately 8.5 seconds and a frivolous and humorous clip of approximately 23 seconds. Each presented a complete idea related to the writing assignment. It was very easy for subjects to, with a click of the mouse, move back and forth between their word processing screen and the video window.

Subjects were part of a beginning computing course for preservice teachers and had been trained on the use of database, spreadsheet and graphics software. Students had, in particular, been trained on using the word processor with which they wrote their compositions.

The writing process was broken into two sessions, composing and revising with a generic problem solving activity used between writing periods as a distractor. The distractor activity was subject-neutral and did not involve the use of the computer, multimedia, or video in any form.

Treatments varied for all six groups of subjects which were randomly assigned to the six treatments. Three categories: (a) exposure at only the composing stage, (b) exposure at only the revision stage, (c) exposure at both stages, were each administered either as single play exposure, viewing each video clip only once at the assigned writing stage(s); or multi-play exposure, viewing each video clip as much as desired during the writing stage(s).

The compositions were blind scored on the subjects' response to video content and the number and management of idea units with the dependent measure being a holistic rating (4=Excellent, 3=Good, 2=Fair, 1=Poor) adapted from Cooper (1977). The factors affecting the standards of excellence applied in this study can be described as follows.

Regarding excellence in the subject's persuasive style and voice, content would show a high degree of sincerity and conviction. There would be a strong vividness or clarity in the ideas presented and a high degree of individualization. A poor performance would be ambiguous and confusing. The task of persuasion would not be fulfilled.

Regarding an excellent organization of content, the essay would be clearly organized and focused. The ideas would flow logically from beginning to end with main points elaborated or explained through the use of specific details or reasons. A poor performance would show little or no evidence of a logical plan or focus. Ideas would not be developed or explained.

Regarding an excellent, overall command of the language, sentences must be correctly written and display variety. The writing must read smoothly from sentence to sentence with no run-together sentences or fragments. Clear, precise word choices are important with few if any errors in grammar, spelling, usage or mechanics. A poor performance would likely contain many errors in structure, with little or no variety. Word choices would be limited or unsuitable with many errors in grammar, usage, or mechanics.

Ratings were analyzed in a one-way analysis of variance with the between group factors being the video exposure treatment. A survey of all subjects was conducted upon completion of the writing exercise. The data collected included the number of times the videos were actually played (only once each in the "single-play" of course), which video was viewed as most helpful in the writing process and subjects' attitudes about the use of videos in general to prompt content for writing.

Results and Discussion

Results of the one-way ANOVA showed that a significant difference existed between treatment groups and writing performance ($F = 3.28$, $df = 5/72$, $p < .01$). The Scheffe's test of multiple comparisons was used to determine the means between which the significant difference existed. See Table 1. Results indicated that subjects who viewed the two video clips only once each during both composing and revising their compositions performed significantly better on the holistic writing scales than did the subjects in any of the other five treatment groups.

Subjects, in general, failed to make extensive use of the video in their writing and essays were not significantly developed. This could be attributable to the limited scope and duration of the video clips. The videos were so brief that they did not provide much material beyond the initial topic presentation with little if any detail. This called for greater imagination on the part of the writers yet they were not students enrolled in an English or composition class. They were educational computing students and this could have affected their tendency to write smaller or more limited compositions.

Subjects seemed to enjoy using the videos and they found the technology very interesting. The serious video clip was consistently judged across all groups to be the most helpful to the writing task in spite of being approximately 1/3 the length of the humorous clip. Interestingly, the number of times subjects chose to play each clip in the multi-play sessions was virtually identical between the two clips.

The survey data also showed that the majority of subjects expressed the opinion that the videos were extremely easy and fun to use. This was true across all groups regardless of the treatment involved. Similarly, most everyone, without regard to treatment agreed with the notion that the videos were very useful in contributing to the writing task and expressed the strong desire to include multimedia video prompts in future writing tasks.

This study is an exploratory examination of the application of very new technology and results should only be accepted cautiously. One group performed significantly better - the single play at each stage of writing. It seems that the video intervention can have a better effect when included at each stage of writing rather than at only one. It may be that multiple plays of the video functions as a distraction rather than a positive contribution for generating

Table 1
Written composition rating results by group

	n	Multi-Play Mean*	n	Single-Play Mean*
Compose Only	13	2.538	11	2.545
Revise Only	14	2.571	8	2.125
Both Compose and Revise	12	2.833	15	3.200**

* 4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor

** Scheffe's test of multiple comparisons: ($F = 3.28$, $df = 5/72$, $p < .01$)

ideas. Students may tend to play the video clips more simply because of the novelty of the multimedia technology instead of using that exposure for developing their ideas.

These video clips were very limited in scope and were very brief when compared with tape or film counterparts. Because digitized video and audio files take up so much space when stored on disk, short videos will more likely be the case unless everyone has access to CD-ROM simultaneously.

Although these results are significant, conclusions are tentative and serve best to suggest further research in applied multimedia. This author has found no research to suggest whether or not a group presentation of video prompt is better than providing each individual student with their own on-screen video presentation and control. Certainly, however, group presentation would allow laserdisc or videotape material to be presented and discussed with only a single player. On the other hand, remember that *QuickTime* is readily available software and does not require the special hardware or expense found in other video technology. And, since writing can be a very personal task, the freedom of individual control may be quite preferable to the highly structured, group approach.

Some things are clear. Students were motivated and interested by the inclusion of multimedia video prompts. They found it helpful, fun and desirable. More extensive examination of and the experimental use of multimedia video/audio in writing and other tasks is highly warranted.

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Collaborative Computer Game Play and the Effects on At-Risk Students

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The strategies children use to solve problems have been described in detail in the past decade (McKinney, 1972; McKinney & Haskins, 1980; Resnick & Glaser, 1976). Understanding the cognitive processes involved in problem-solving tasks may lead to a better understanding of how information is integrated and manipulated by the student. Researchers have focused on investigating the cognitive processes involved in these tasks. They have hypothesized, grouped, and labeled specific behaviors to document cognitive strengths and deficiencies.

These processes have also been explored to substantiate theories that students who are academically at-risk either lack or fail to use the same cognitive processes as their peers. Deficiencies have been found in low achieving students on metacognitive performances when compared with normally achieving peers. Consequently, it is likely that cognitive deficiencies contribute to the problems that low achieving students experience with problem-solving activities.

The cognitive skills related to defining and solving problems have long been used to evaluate tasks on the computer (Gagne, 1982). A conceptual framework that identifies and classifies specific cognitive and critical thinking skills has been created to better analyze software programs (Cradler, 1985). Higher level thinking skills, particularly problem solving tasks, are easily controlled with the computer. Not only answers, but also the steps used to achieve an answer, may be recorded. Tasks may be adjusted to the level of difficulty required by the student. Programs may be written on any subject and problem-solving tasks may cut across academic disciplines. In other words, problem-solving programs "constantly evaluate student performances while selectively altering different features of the environment, curriculum, or instructional conditions" (Carlson & Silverman, 1986, p. 106).

In addition to being a good problem-solving tool, the computer has many other advantages. As an assessment measure, the computer accurately records responses, controls the testing environment, adds impartiality and may capture the interest of the student to add an incentive or motivating factor (Greenfield, 1984). The computer, therefore, is a logical tool to use to assess these cognitive skills. The present study was completed in order to more specifically examine possible areas of deficiencies or strengths in problem-solving abilities of students academically at-risk. Using the computer as an assessment tool, it measured the performances of at-risk students based on teacher identification and problem-solving tasks. Field notes written by college tutors participating in this study were analyzed for insights into student performances. The children studied were part of the *5thDimension*, an after-school program to supplement daily education which mixes activities of affiliation, play, study, peer work, and theorizing through the use of computers (Nicolopoulou & Cole, 1991). Through this framework, researchers study education environments from formative experiments on technologies that create different organizations (Newman, 1990). This study was completed to answer the following questions: 1) Can the microcomputer equalize deficits and aid the student who has problems with traditional teaching and testing environments? and 2) Can the computer give educational researchers an insight into the social environment as an integral part of the process of cognitive change?

Method

Subjects

The at-risk students in this study were selected from a total population of 56 students participating in an after school program at an elementary school serving students from grades kindergarten through 8th. Two of the four students (TJ and JN) were receiving Chapter 1 reading services. These students qualified for this program by their school district following state and federal guidelines for Chapter 1 reading. These guidelines required below grade reading performance in the classroom and 49 percentile or below on the reading achievement test. These two students were in the 2nd and 3rd grades; one female and one male. The ethnic composition of this group was 100% Caucasian.

One student (AC) was classified as learning disabled using district and state guidelines. These guidelines require a severe discrepancy between achievement and potential using a standard score difference of 15 points or greater. She was a Caucasian female in the 2nd grade.

The final student (DW) was labeled as Willie M. This is a classification in North Carolina for children with emotional, mental, or neurological handicaps who are highly violent or assaultive. The majority have educational achievement deficits in comparison to their ability. He was a Caucasian male in the 5th grade.

Tutors

The tutors in this program, two males and two females, were completing a field experience for an undergraduate college level course, *Introduction to Teaching*. The majority of the time the same tutor would work with the same assigned student. These undergraduates provided a critical mass of socialized participants willing to abide by the rules of the after school system. They were admired by the children, providing role models not only in terms of social behavior but in terms of literacy and problem-solving skills (Blanton, 1992).

Instrumentation

Field notes written by tutors on students, teaching methods, interactions, games and outcomes were sent on electronic mail to the cooperating professor to encourage reflection and shared inquiry into experiences as part of a teacher project. The instructions for these field notes were as follows:

Concentrate on describing the interaction between you and the child(ren) as accurately and thoughtfully as your can. Just reflect back on what went on at the site, how you interacted with each other. Be sure to note how you and the child(ren) arrived at a specific activity, what their reaction was to the activity, and what difficulties or problems they encountered when dealing with the game. Pay close attention to dialogue, language use and strategies the child(ren) attend to during the course of the game. Remember that negative instances and ways the interaction breaks down, or misunderstandings about the games are as interesting as positive instances; in fact, they are very informative when we try to understand what goes on during the positive instances.

Procedures

Students involved in this study and the *5thDimension* were presented with a set of shared rules and customs which had been collated in a constitution. This constitution included directions for getting started, and special things to remember, and could be amended by agreement of the community. The students followed a maze on a sheet of paper which listed computer programs to choose from, a journey log to keep a record of activities, dates, and progression of beginning, good, and expert. The students were also required to write to the Golem (an imaginary person) about their progress.

Results

Student Use of Games

TJ played computer games ten times using six different games during a 6-week period. She wrote to Golem twice, wrote to a Russian pen pal once, and played a non-computer game, *Othello*, twice.

AC wrote a Russian pen pal twice, played a non-computer game, *Othello*, twice, and refused to write to Golem. She played computer games five times using four different games during a 6-week period.

JN used five different computer games using them six times. He wrote three letters to Golem and played a non-computer game once over a 4-week period.

DW wrote Golem once, played one computer program, and played one non-computer game over a 2-week period.

Specific games played and comments made by tutors were recorded in field notes.

Field Notes

The following are brief summaries of field notes written by tutors. TJ was referred to with terms such as perseverance and learned apathy. TJ"s tutor began identifying with TJ and wrote that the two of them matched perfectly because they were both: shy, didn't like to be observed, would rather do their own thing, are left-handed, neither knows anything about computers, had trouble with attention and reading in the first and second grades, and hated reading aloud. The tutor began encouraging TJ to keep a diary of notes on games as a backup to her memory. TJ began internalizing rules and correcting herself. She also began correcting her tutor on computer games. TJ kept playing familiar games, slowly adding onto her repertoire. The tutor also questioned the idea that TJ was labeled as a"trouble maker" and that this label may be encouraging inappropriate behaviors.

The tutor working with AC was nervous. She reported in her final field notes that she had no "earthly idea that my child was an LD student" until the end of the semester. She also wrote that "with the proper atmosphere LD students can flourish just as much, if not more so, than typical students." She reported the feeling of "awesome" power and responsibility when working with AC and warned others not to let prior knowledge limit expectations of students because you, as the teacher, could limit your students.

Communication was seen as an initial problem between JN and his tutor. The tutor wrote, "Effective communication is one of the most important skills a teacher must understand and use". The tutor wrote about the need to supply some extrinsic motivation, but that every child is different and learns a little bit differently.

DW did not work with a tutor more than two times, yet there was still an improvement seen between field notes on both game performance and attitude.

Discussion and Implications

The results of this investigation support the contention that students academically at-risk can perform successfully on computer activities. It is too soon to note long term attainment from successful performances within this study. Other 5thDimension Projects, however, have been in place since 1987 and have shown long term accomplishments. The answer to research question #1 is yes, the computer has the potential of aiding the student who has problems in the traditional educational setting. Some measure of success was shown by all four at-risk students. It is too early to tell whether the computer can give educational researchers an insight into the social environment as an integral part of the process of cognitive change. The results of this study, however, were very promising in this area.

Several theories may help explain the success of all four at-risk students in this study. The first may deal with the computer as an active versus passive tool. Unlike passive technologies such as television, computers require the user to make choices, view the consequences immediately and receive timely feedback (Mann, 1989). In the *5thDimension*, students are experiencing an increased quantity and quality of time on task by the active, voluntary, engagement of children motivated by the tasks themselves (Cole, Quan, & Woodbridge, 1992). The key word voluntary, creates an atmosphere where the students are choosing to participate. Instead of the teacher telling the students what they will be doing next, voluntary adds the responsibility of performing onto the students.

This program also mixes academic learning and play which may enhance participation and should be noted by educators. The basis for the creation of the *5thDimension* program was the Vygotskian perspective that the formation of the mind is a sociocultural process that may be completed only by situating individual development in its sociocultural context (Nicolopoulou & Cole, 1991). This generation and transmission of shared knowledge may not exist as a passive interaction, thus in setting up a learning situation in this manner, you are setting the child up for active learning.

A second rationale for success may be that computers make up for the deficits of students in the typical classroom. Computers may enable educators to match academic tasks with the learning preferences of academically at-risk students (Carbo, Dunn, & Dunn, 1989). The computer has been successful as a viable alternative to providing the kind of educational experiences that at-risk students need to complete academic tasks (DeVillar & Faltis, 1991).

Finally, one may gain a better understanding of the success found by these at-risk students by reviewing the literature on achievement goal theory. There are predominately two motivational orientations among students: learning-focused and ability-focused (Ames, 1987; Dweck & Leggett, 1986; Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990). Learning-focused students are motivated by acquiring the necessary skills and problem-solving skills necessary to understand and complete the task at hand. In contrast, ability-focused students are interested in competition and are concerned about their ability compared to other students. When we observe at-risk students contradicting their stereotypical qualities, such as the use of self correction, what we may be seeing is a switch in goals and motivation and thus, a switch in performance. With TJ, we saw a switch from ability-focused performances to learning-focused skills such as monitoring comprehension, connecting new information with prior knowledge, and discriminating important from unimportant information (Ames & Archer, 1988).

The goal may identify how we can make school tasks more interactive, fit learning styles, and be more intrinsically rewarding. For years we have isolated computer tasks to rewards or to reinforcement of skills taught in class. Few teachers take the time to facilitate computer use or require that computers be used as tools to accomplish lesson-related tasks (Smith, 1989). Even though we have seen performances on computers between groups of non-at-risk and at-risk students fall within a common range (Zimmerman, 1988), we continue exploring very limited ways of using the computer to equalize deficits and aid the student who has problems with traditional teaching and testing environments

At-risk students and students with learning disabilities may be slower at performing tasks on the computer, but from the performances in this study, we have seen only successes, not great differences between students. It is interesting to note that the tutors in this study, who were teaching novices, were experiencing and reflecting on successes in teaching and learning in ways that traditional methods of education are not grasping. The role of the computer in education for all students must be that of providing enrichment-based, discovery-oriented learning opportunities. With the use of this technology for instructional purposes, the gap of existing disparities in academic achievement between groups may be closed.

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Comparisons of Spontaneous and Word Processed Compositions in Elementary Classrooms

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The personal computer has evolved from a sophisticated expensive instrument for research to a relatively inexpensive, multi-purpose teaching tool. Teachers are becoming more and more comfortable with the computer as a tool and less fearful of it as a robotic replacement for a human teacher. They are endeavoring to explore its potential as an alternative teaching strategy in the classroom. Its value in the science and mathematics classroom is well researched and documented. However, its integration into a creative writing program as a teaching tool seems to have untapped possibilities.

Most professional writers and journalists use word processing exclusively without need for paper and pencil. Can young children who are just beginning to write creatively compose as well using a computer as they do using conventional means? Yau (1991), in a study involving elementary students, stated that if the full realization of word processing potential is to be achieved the following conditions should be met:

> (1.) A teacher must be actively involved in the process both as instructor and facilitator;
> (2.) The word processor should be employed in conjunction with, rather than in place of the other writing tools;
> (3.) Teachers and students should have enough access to computers and printers to ensure that the word processor can be fully integrated into writing classes; and,
> (4.) Teachers need to be supported and facilitated. (p. 19)

Bryson (1986), in a study of eighth grade students, indicated that the "talented students, without the concomitant distraction of editing while composing on the computer, created valuable content in their preliminary drafts and then significantly improved their texts through global revisions. However, results suggested that the provision of word processors benefited neither the writing processes nor products of the average students" (p. 16). On the other hand, Larter, Braganca, and Rukavina (1987) reported that for elementary school children, particularly in primary grades, using microcomputers increased and improved their writing. Further findings indicated the writing process with microcomputers differed from the traditional process of writing. This research project was completed using few computers and students from the first, third, and sixth grades. Moore (1989) reported that a pilot program in a fourth grade class indicated students using word processors significantly improved the quality of their writings.

Most of the research reviewed involved upper elementary to young adult students. The present study was performed using third grade students in a self-contained classroom, which in itself presented problems not present in a situation in which the teacher is responsible for only a single subject. On the other hand, the self-contained environment allowed for integration of reading/writing skills into other areas as well. Although younger children do not have the life experience to draw upon, they are less inhibited about writing and using their imaginations.

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Methods

In conjunction with efforts to encourage pre-service teachers and elementary education majors at both Southeastern Louisiana University and the University of South Alabama to engage in productive research, become consumers of research, and learn constructive uses for the microcomputer in the elementary classroom, the following research study was initiated. Throughout the preparation and field trials of the research, student teachers were involved in the construction of an evaluation instrument, in the actual grading of student responses and in the observation of both writing processes in the classroom. Their input and criticisms were solicited by their methods' instructors, university supervisor, and inservice teacher throughout the study Students at Southeastern Louisiana University and the University of South Alabama take a required course in the use of microcomputers in the classroom. The software being used in the experiment was tested in those classes.

The subjects in this three-year study were third grade students attending a public school in a large urban center in southwest Alabama. The students represented a range of intellectual abilities and socioeconomic levels. The class was predominantly Caucasian and male, taught by one teacher in a self-contained classroom. Students were assigned a number to maintain anonymity.

The students in the first year used their English textbooks for story starters. In the second and third years, the textbook was not the exclusive source of the story starters. Normal classroom instruction was used for this section of the research. Students received from their classroom teacher approximately six weeks of training (mainly in keyboarding skills) on IBM computers using *Primary Editor Plus*, a simple word processing program. All computers were networked and attached to a printer. After the training, students were allowed to write compositions again using story starters. Typically, the same amount of time used to write the compositions in class (a thirty-minute time block) was allowed for writing the compositions in the computer lab. Although later efforts were made to maintain some uniformity in subject matter, it was not always possible to use the same topics for the computer generated material as for the hand work.

In the third year an additional teacher was used in the study. This teacher had an Apple IIe computer and allowed students to write compositions as time permitted. The word processing program used was *Word Handler*. The composition of this classroom was similar to the other in size, racial and gender mix, socioeconomic levels, and intellectual abilities. As close as possible, children were given the same amount of time to complete each writing.

Review was done by an independent panel of classroom teachers and the two researchers. Quality, length of the story, spelling, and grammatical errors were monitored but no numerical value was assigned to each of the writings.

Format for Assessing Compositions

All papers, both handwritten and computer-generated, were reviewed by independent readers (university instructors and student teachers) who used the following criteria: originality, grammar and syntax, spelling, neatness, length of the compositions, and completeness of thoughts expressed. Both in the pilot study and in the follow-up, evaluation was done subjectively. Students and student teachers have been working on an evaluation instrument which when validated will be used for the next student submissions.

Criteria for Evaluation:

1. Originality 5 pts.
2. Grammar & Syntax 5 pts.
3. Spelling & Punctuation 5 pts.
4. Neatness 5 pts.
5. Length 5 pts.
6. Completeness of Thoughts Expressed 5 pts.
7. Clarity and Coherence 5 pts.
8. Use of Abstract Concepts 5 pts.
9. Ability to Make Assumptions & Integrate Information 5 pts.
10. Legibility 5 pts.

Teacher Influence:

1. Guidance Throughout Exercise -5 pts.
2. Minimal or No Guidance from Teacher 5 pts.
3. Pre-writing Teacher Input
   a. Grammar and Spelling Instruction 3 pts.
   b. Use of Story Starters -3 pts.

Variables:

1. Intelligence level of students within context of grade level;
2. Language of Instruction;
3. "Editorial Opportunities" (do they edit own or other work?);
4. Level of Writing Skill
5. Penmanship
6. Physical/logistic Limitations:
   a. Time allowed for exercise
   b. Context of written exercise (class assignment?)
   c. Classroom environment

Results

Preliminary observations revealed: the handwritten submissions were significantly and consistently longer than word processed versions (sample is provided at the end of this paper); there were more punctuation errors in the computer reports; spontaneous writings, in the computer lab, appeared less creative and demonstrated less imagination than those from "story-starter" texts, used in the classroom.

In the second year review, much the same result was evident. The handwritten work appeared better organized, was longer, and seemed to better express what the child was thinking. The computer-generated writing appeared stilted, was brief to the point of insignificance, and had only one point of superiority: neatness. The third year is currently being completed.

Implications

Generally the results from this pilot study are comparable to previously reported studies (Yau, 1991, Bryson, 1986). This study does not support the findings of Larter, et al.; Moore; and Hoot and Limler. We must, however, consider the variables and distinctions which set this study apart— such things as age and intellectual level of students, and learning environment.

Implications for future research include: objectivity in scoring written compositions, consistency in instruction for both treatments, development of an evaluation instrument to be used by the teacher to determine the effectiveness of the computer as a teaching tool, and investigation of the child's ability to develop abstract concepts in composing on a mechanical device.

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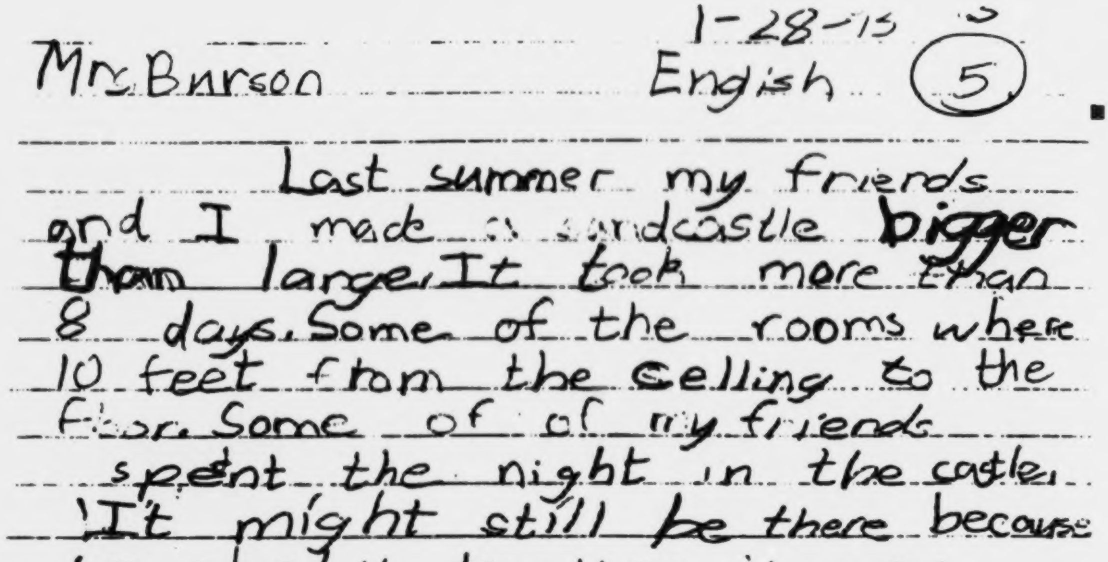

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Mr. Burson English ⑤

Last summer my friends
and I made a sandcastle bigger
than large. It took more than
8 days. Some of the rooms where
10 feet from the celling to the
floor. Some of of my friends
spent the night in the castle.
It might still be there because
we glued it together, it was
lots of fun.

CONCEPTS AND PROCEDURES

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In the well known musical *The Music Man*, the main character, Harold Hill, begins the story by proclaiming "There's trouble in River City." In the same vein, but far more seriously, David Byrum, Cyndy Cashman, and Phyllis McCraw begin this section on concepts and procedures by sounding an alarm. In *The Educational Computing Backlash*, the authors argue that the technology revolution has failed to eradicate the problems of the schools, and they identify a series of four factors for the failure: (a) resistance to change; (b) lack of results; (c) inappropriate use of technology; and (d) what they call the *magic factor*, the claim that computers are "somehow essential to preparing students for the future". They argue that not all schools have or will have access to the latest technology, and that more should be done to make good use of "trailing edge technology". Further, they make a strong case for reasonable, not inflated, expectations of what educational technology can or will accomplish. Finally, the authors call upon pre-service university faculty to model the effective use of technology in the classroom.

Despite the alarm sounded by the lead paper, there are successful implementations of instructional technology. Four papers identify such techniques. The first, by Evelyn M. Dailey of Towson State University, entitled *Integrating Cooperative Learning, Word Processing and the Writing Process*, describes a controlled study contrasting two groups of thirty students each, with one group engaging in cooperative writing, and the control group using traditional methods. Dailey found statistically significant differences between the experimental and control groups at the drafting and revising stages of writing, but found no such differences during the planning stage.

Henry Kepner, Jr. describes a National Science Foundation funded in-service training project designed to integrate technology into the math and science curricula. *Teacher Teams Integrating Technology into the Mathematics/Science Curriculum* provides an overview of this three-year program, and identifies factors that led to successful implementation in the classroom.

In *What Makes an Effective Computer Projected Presentation? Suggestions from the Audience*, Donald Grandgenett, Neal Grandgenett, and Neal Topp acknowledge the impact that such presentations may have. But they argue that the mark is often missed because of failures or omissions of the presenter, the structure of the presentation, the environment, or the equipment. They present a series of suggestions to reduce the probability of presentation failure.

The Network University Lectures Concept by Franz Steinparz reflects upon the potential of distance learning courses, disseminated over computer networks. Steinparz identifies a weakness in current software to provide smooth integration of CAI and electronic communication functions, and suggests the development of a smart communication system that automatically directs student queries to the appropriate instructor.

Three papers deal with pre-service teacher preparation. The first, *NCATE Standards and Technology Education*, by Trudy Abramson, abstracts the section of the standards that pertain to technology.

In *A Model for Using Anchored Instruction in Preservice Educational Technology Classes*, Jeffrey Bauer, Eric Ellefsen, and Adele Hall stress the importance of creating "an anchor or focus around which instruction can take place." They present examples of how thematic software such as *Oregon Trail* is used in their courses to encourage future teachers to develop classroom projects incorporating computer applications such as word processing, drawing, spreadsheet manipulation, optical scanning, desktop publishing, hypercard stacks, and presentation graphics.

Also using anchored instructional techniques, Dave Edyburn, Herbert Rieth, and Linda Bishop describe their federally-funded Technology Enhancement Teacher Training (TETT) project. They detail the features of *Teaching Assistant*, a multimedia shell software package they have designed. *Teaching Assistant* provides teachers with a software toolkit incorporating multimedia, word processing, database, spreadsheet, telecommunications, graphing/drawing, desktop publishing, and presentation tools, all in a single integrated package.

Cheryl Murphy describes five software tools in three general areas, (a) CAI authoring tools, (b) presentation tools, and (c) concept mapping tools, and shows how these can be effectively integrated into university-level education courses. In her paper, *Five Practical Examples of Software Integration in University Level Courses*, she provides concrete examples of how these general tools can be utilized in a variety of settings.

The remaining four papers are somewhat more difficult to categorize. In *Curriculum-based Single Switch Applications*, Edward Burns describes how technology can be adapted to the needs of cognitively able students with severe communications handicaps.

Gary Schroeder's *Implementing Information Systems in Colleges of Education: Narrowing the Gap Between Theory and Practice* describes the design and implementation of an information system in a university education department.

Jerry Price and Jerry Willis cover the basics of producing a locally-developed CD-ROM that can be read by Macintosh or IBM computers in their paper,*Creating Your Own CD-ROM: An Overview*.

Finally, *Building Faculty: Reflective Decision-Making and Developing a Faculty Kiosk* reports on the positive effects that the decision to design an interactive kiosk had upon a university education department.

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The Educational Computing Backlash

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> Beyond the fact that a great deal is being lost and squeezed out of the curriculum in the attempt the computerize it, and beyond the fact that the computer revolution in the classrooms is serving the purposes of one part of the culture which is trying to dominate the rest, what a tremendous distraction this revolution has turned out to be. In the meantime, what has now become a litany of educational problems still exists. Some of these, like declining literacy and increasing dropout rates, are getting worse. In the end the problem is not merely that the prophets like Papert are proving to be false, or that the movement they have promoted has proven to be a great distraction: this movement has also placed a great burden on educators who are having enough trouble mastering the system as it now stands. (Dublin, 1989, pp. 205-206)

There is a technology backlash in America that has extended itself to the use of computers in education. Positive reports have turned into negative stories of how computers have been misused by technologically illiterate teachers and the message is about the failures of computers to make any significant changes in education. Consider the headline, "The Revolution That Fizzled" (Elmer-Dewitt, 1991). This headline is just one example of the negative references to computers in education found in recent media reports. As Maddux, Johnson, & Willis (1992) contend, much of this negative publicity can be attributed to the "pendulum syndrome" in which new innovations are subject to unrealistic expectations, followed by disappointment, and ultimately abandonment. Dublin (1989) contends that education is especially susceptible to faddism and outside forces, "When one hears talk of imminent revolutions in our education system, it is important to bear in mind that, next to the military, perhaps no other part of our culture is as susceptible to becoming the subject of propaganda as is our education system" (p. 174-175).

Are there other reasons for this backlash? This paper will look at several reasons why the authors feel there is a backlash on computers in education. Several of the reasons this paper will expand upon are: (a) resistance to change in schools; (b) over-commercialization and the 'magic factor'; (c) lack of results; and (d) inappropriate use of technology.

Resistance to Change in Schools

In an article by Arthur Luehrmann (1990) in *The School Administrator,* Luehrmann expressed skepticism that educational technology will bring any fundamental change in schools. Luehrmann quotes Michael Krist, an expert on educational change, "If your great grandmother came back to visit a classroom today, she would recognize almost everything. In the last hundred years, the only classroom innovation that has taken root is the moveable desk"(p. 14). Even when change has taken place and technology has been purchased, it has often been for all the wrong reasons as discussed later in the paper.

Hannafin and Savenye (1993) believe that a large part of the lack of technology usage in schools is the resistance of teachers to take on a new role. With this shift of roles in which technology would play a large part, much of the responsibility of learning moves to the student. Hannafin and Savenye explain that the teacher's role can be viewed on a continuum. At one end, is the role of traditional lecturer and imparter of knowledge and generally embraces the objectivist point of view. At the other end, the teacher takes on the role of coach, observer, and facilitator which is based on a constructivism viewpoint. Many teachers use low-level activities because they can control the instruction which coincides with their view of learning while other teachers use computers to facilitate open-ended or problem-solving environments in which the teacher must relinquish some control.

Making this change even more difficult contend Hannafin and Savenye (1993), is the fact that schools (teachers) behave in accordance with the norms and expectations of the society at large. Teachers have been expected by society to control the class and any innovation in which students control their own learning is bound to fail. Society holds collective views about the student-teacher relationship. This belief is that knowledge is imparted from the teacher to the learner and this belief may hinder any teacher from straying too far from the norm. Thus lies the contradiction, "While on one hand, society supports the rapid and complete implementation of microcomputers in education, it may, on the other hand, resist certain uses of computers" (p. 29).

While many believe teacher resistance is the main cause of limited computer use, others feel this has little to do with the problem. Rather the concern is with the management of technology by school administrators. It is common knowledge in many school districts (McCraw, 1993) that the schools that have technology and are using it successfully are those in which there is an actively interested administrator.

Too often teachers are tasked with making technology a viable part of their instructional strategies but given no tools to make that happen. The following information was revealed in a case study (McCraw, 1993) conducted in a southwestern rural school district. Teachers were introduced to computers in the early 1980s but had no background or training to make them a credible part of their instruction. Yet, they tried until 1992 to implement the mandate of school board, administrators, and patrons of their school to make some sense of the technology that was provided to them. The result of the study indicated:

1. Teachers were expected to learn to use computers on their own time without any guidance, or remuneration for their efforts.
2. Hardware and software were inadequate to be used for instruction or even as a teacher tool.
3. Administrators had influenced the uninformed school board to purchase equipment without providing any funding for teacher training or demanding any accountability for their use.
4. Technology was acquired without a plan, often by grant writing which provided incompatible equipment with a confusion of formats, disk size, and machine types.
5. Assorted teachers who became interested in technology were actually "gatekeepers" to the technology instead of acting as resources for other teachers in the school.

Lack of Results

With much of the public today demanding results from both government and education, it is no wonder that a skeptical eye is turned towards the established benefits of computers in the schools. To the layman, such articles as "The Revolution That Fizzled" by Elmer-Dewitt (1991) of *Time* magazine further cloud the issue. Two failures of educational computing play most prominently in this article. First, was the Belridge school district in McKittrick, California in which every student had two Apple IIgs computers, one at home and one at school, and a curriculum that made use of computers in all subjects areas. Yet the entire first grade class along with one-third of student body scored below grade level for both reading and math on annual standardized tests. The second major report revolves around the questionable benefits of IBM's *Writing to Read* program in which many school districts have made sizable investments. The article calls into question this program, "Several research articles, including the one last summer in the well regarded *Journal of Computer-Based Instruction,* have suggested that any benefit kindergartners get from *Writing to Read* derives more from the extra attention provided by the supervising adults" (p. 49).

An examination of research studies by White (1992) and Bracey (1988) reveal mostly meager results. An article by Gerald Bracey in *Electronic Learning* summarizes the conclusions of a study conducted by Henry Becker of John Hopkins University comparing computer supplemented instruction with traditional instruction. Becker did not consider studies prior to 1984 and removed many others for poor design, inadequate measures, no random assignment , and a less than nine week treatment. Of fifty-one studies, thirty-four were eliminated. Only two of the remaining studies showed highly significant results. The remaining studies showed either small effect sizes or even negatives ones.

Inappropriate Use of Technology

Another condition that seems to be prevalent of late is what we call "technology in search of a purpose". As new advances are made in areas of technology, the next question appears to be, "Now that we have this technology, what can we do with it?" Often it appears to be much the same way in education. Many teachers are using computers in the classroom in ways which are not based on theory or shown to be effective in studies. Maddux, Johnson, & Willis (1992) call this "Innovation in the absence of evidence".

Another danger lies in the ability of computers and multimedia to substitute style over substance. Martin Huntley (1991) describes seeing the IBM multimedia program Ulysses at a conference. As the program drew to a close with a whirlwind of emotion packed images, the author stood and cheered along with the audience before he realized he had been "had". Huntley states, " Most of the images had no special connection with the poem or the interpretations that had been explored... I came away wondering whether the technology hadn't contributed to a devaluation of content, a victory of style over substance"(p. 3). Huntley fears that these technologies will actually accelerate the decline of literacy, substituting 30 second entertainment clips rather than intellectual content or emotional depth. Steven Levy in *MacWorld* (cited in Huntley) feels that "We face the future where our business reports and school papers aspire to the standards of a Def Leppard clip in heavy MTV rotation" (p. 3).

Magic Factor and Commercialism

There is a perception in society that the presence of computers in schools is somehow essential to preparing students for the future (Cashman, 1992; Bosco, 1986). We refer to this belief as the "magic factor". The magic factor was observed by Cashman (1992) in her study of undergraduate students enrolled in a Computers in Education course. Students entered the course with vague perceptions of the role of computers in society and education. However, most students expressed a belief that "computers are the future".

McCraw (1993) observed teachers, administrators and school board members embracing the "magic factor" in her study of rural elementary school teachers beliefs about computers. Teachers had brought home computers for their children believing that they would help prepare them for the future; even though they themselves seldom used them and had limited skills. Administrators and school board members purchased computers to increase the quality of their school. Educational goals or objectives for which the computers would be used to meet had not been identified. Neither had an implementation plan been designed for training teachers to use the computers.

The "magic factor" that has influenced the purchase of thousands of computers for schools was a marketing technique used by Steven Jobs of the Apple Computer Company in the 1980s. Apple sold the public and educational community a vision; computers possessed mystical powers that ensured a fun and magical education that would prepare students for the future (Rose, 1987). Companies have continued to utilize the "magic factor" in advertisements for their educational computing products. For example, a recent advertisement for a software product stated, ". . .give students the right learning program and they'll teach themselves." These inflated claims result in unrealistic expectations that somehow technology can solve the ills of education.

Conclusion

Will computers be another technological innovation that will ultimately have very little impact on education in the future? Many new instructional and technological innovations in education have been subject to the "pendulum syndrome" in which there are unrealistic expectations, followed by disappointment, and ultimately abandonment (Maddux, Johnson, & Willis, 1992). However, unlike other technological innovations that have previously been introduced with great educational promise, then removed to the storage room, the computer will take a more prominent role in education in the future than it does today. Presenting the potential of computers as learning tools in a more realistic fashion, perhaps will help break the cycle of disappointment and backlash that seems to be inevitable with new innovations.

This paper has presented several of the reasons there may be a growing negative attitude or backlash against computers in schools. The following are suggestions for presenting technology to preservice teachers:

1. Present a realistic picture of computers in schools. Remember not all schools have cutting edge technology such as modern networked computers labs, multimedia, CD-ROM, and laser videodisc. Spend some time talking about and demonstrating "trailing edge technology" and what can be done with older computers and less than ideal situations. Although our students should be familiar with the newest and best in technology, they shouldn't get discouraged and give up on technology usage just because it isn't the latest model.
2. Present a realistic picture of what computers can do for education. Don't be tempted to make over-inflated claims that seem to make technology a cure for all of educations' problems. Encourage pre-service teachers to use computers in those areas are known to work. While many are still undecided about the real cognitive gains and benefits of using computers, there appears to be no question about the strong motivational force that computers have on students. Pre-service teachers should not take this finding lightly. Sometimes motivation is all that is needed to turn a difficult or reluctant learner around.
3. Model effective use of computers in your classes. Byrum & Cashman (1993) found in a survey of preservice teachers that 77% had been exposed to computer-aided instruction in one education class or less. In most instances, the only class in which preservice teachers were exposed was the technology class. Make sure preservice teachers observe classes and schools in which technology plays an important and integral role in instruction. Also have students practice using computers in their model lessons and lesson plans. Byrum & Cashman found that fewer than 24% of students had been required to integrate computers into lesson plans or projects. Pre-service teachers need to understand that classes in which technology is effectively used often resemble chaos to the non-technology using educator that prefers more control.
4. Make your students informed consumers. Teach them to beware of computer and software companies and the claims they may make. Have them ask, "Why do you want to sell me this system or this software? What proof do you have that it works?" With the proliferation of pre-packaged Integrated Learning Systems, teachers should be asking for field-based data from the dealer which show the system's effectiveness.
5. Eliminate the 'magic factor'. A computer alone is not magic, students don't learn just by sitting close to it and

schools don't become better just by purchasing the latest network. What makes technology work is committed teachers, a supportive administration, and a well thought out plan which includes input from both of these concerns. It is imperative to recognize that the source of most "teacher resistance" to technology is the unwillingness, and in some cases ignorance, of the schools to provide teachers with the resources to make the technology valuable to them. Training, time for development of the computer as a tool, and most of all, a plan to follow is necessary if teachers are to meet the challenge of technology in today's education.

6. Make sure prospective teachers know that they are the most important piece in the technology puzzle. Computers will never replace good and caring teachers and basic learning should not suffer at the expense of technology. Jean-Louis Gassée (1992) states," As a remedy for our failure in the basics of learning, I am afraid to see computers played as an escapist substitute for smaller classes, more teachers and more individualized instruction. Let's have all the computers we want, but only after we give our children the human learning conditions they need" (p. 42).

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Integrating Cooperative Learning, Word Processing, and the Writing Process

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There is broad based agreement among educators that no skill is more vital to students than writing. Writing is a skill which can (a) contribute to improved performance across curricula, (b) increase personal productivity, and (c) lead to a marketable job (Panyan & Dailey, 1989). Increasingly, more occupations require workers to process information; consequently, individuals must communicate through written language and depend on written communication from others (Scardamalia & Bereiter, 1986). Yet for the last two decades, researchers, educators, and members of the business community have chronicled the writing deficiencies of students. This decline in student writing ability has been documented in several national reports such as The National Commission on Excellence in Education (1983), The National Assessment of Educational Progress Report (1990), and the National Assessment of Educational Progress's The Writing Report Card: Writing Achievement in American Schools (Applebee, Langer, and Mullin, 1986).

More specifically, researchers have noted that writing deficiencies emanate from three areas: idea generation, text organization, and metacognitive strategies (Englert & Raphael, 1988). Numerous effective instructional practices for writing instruction have emerged. One specific writing practice, the process approach, has demonstrated repeatedly its effectiveness in addressing the deficiencies of student writers (Bos, 1988; Graham & Harris, 1988; MacArthur, 1988).

Cooperative learning techniques have also been investigated in conjunction with computer- assisted instruction (Cosden & Lieber, 1986; Cox & Berger, 1985; Lieber & Semmel, 1987). Johnson, Johnson, and Stanne (1985) concluded that computer-assisted cooperative instruction promoted greater achievement, more successful problem solving, and improved performance on factual recognition, application, and problem-solving test items than did computer-assisted competitive or individualized learning.

Recently, researchers have investigated the effects of word processing on student writing. Behrmann (1984) and Brill (1987) have noted that the word processor has enormous potential as a tool to support improved writing for students. However, word processing alone will not enhance writing; an appropriate instructional strategy is the key element to the successful use of word processing in the classroom (Sitko & Crealock, 1986). The purpose of this study was to determine the efficacy of cooperative writing teams on the written performance of secondary students assigned writing tasks at the computer.

Method

Subjects

Sixty students from two suburban high schools in Maryland, grades 9 - 12, were recruited from six remedial English classes. These individuals, ages 14 - 17 years old, were identified as having mild handicapping conditions — either learning disabilities (LD), emotional disturbance (ED), at risk (AR), or English as a second language (ESL) students. In order to be included in the study, those students with learning disabilities (LD) or emotional disturbances (ED) had to (a) have been identified by an Admission, Review, and Dismissal (ARD) committee as being LD or ED according to state and federal regulations; (b) have had an existing deficiency in writing skill noted on an individual education program (IEP); (c) be placed in a special education classroom with a certified special education teacher; and (d) have parental permission to participate in the study. All students placed in the remedial English classes had to perform (a) below the 70th percentile on the Minimal Grade Competency Test (MGC), a curriculum-based assessment measure; and (b) two grade levels below the expected reading level as measured by the California Achievement Test. The characteristics of the students in terms of sex, ethnicity, and disability are found in Table 1.

Independent Variables

Two conditions were implemented and compared over the course of seven weeks: Cooperative Writing Teams (CWT) and a control condition (C). CWT were defined as groups of three students working with the preassigned roles of Recorder, Keyboarder, or Checker. The control condition was designed to be identical to the CWT conditions except for the absence of the CWT. Therefore, students were not given the opportunity to work together or earn team points associated with CWT.

Dependent Variables

To determine the relative efficacy of each of the independent variable conditions, two dependent variables were assessed: T-units and MHS. A T-unit was defined as a segment of meaningful expression that contained an identifiable verb and subject which could stand alone (Flower & Hayes, 1980). MHS were defined as numerical values (1 - 4) based upon the primary writing traits of content, organization, audience, sentence formation, and conventions.

Procedures

The following procedures were implemented for all classes prior to assignment to experimental conditions. A survey and sample exercise were administered to the students to determine prior knowledge of and experience with word processing. The experimenter used the survey results to balance the CWT.

Two individual writing samples were elicited from each student before assignment to experimental conditions. Two independent readers determined the number of T-units for planning, drafting, and revising activities, and they also determined a MHS for the drafting and revising phases using the rubric established by the Maryland State Department of Education. This writing sample was the pretest. To determine if the effects of the treatment generalized to other writing situations, students were asked to complete a second writing sample. Students responded to the 1988 Maryland Writing Test narrative prompt. The same procedures regarding assessment were followed for these writing samples.

The two treatment conditions were then implemented. Writing took place four days a week for 50 minutes each day over a seven week period. Students were allowed one 50 minute period for planning, two 50 minute periods for drafting, and one 50 minute period for revising. Three writing assignments were completed under each condition, and each writing sample took approximately one week to complete.

Following the treament conditions, students completed two writing samples. One writing sample was the posttest and the other was a generalized measure of writing, The 1989 Maryland Writing Test (MWT) narrative prompt. The same procedures regarding the measurement of T-units and

Table 1
Stratification of Student Sample for Sex, Ethnicity, and Disability

Variable	Control (N = 30)	Experimental (N = 30)
Sex		
Female	15 (25.0)	10 (16.7)
Male	15 (25.0)	20 (33.3)
Ethnicity		
African-American	4 (6.7)	11 (18.3)
White	19 (31.7)	17 (28.3)
Asian-American	7 (11.7)	2 (3.3)
Disability		
Learning Disabilities	2 (3.3)	14 (23.3)
At Risk	17 (28.3)	12 (20.0)
Emotional Disturbance	3 (5.0)	2 (3.3)
English as a Second Language	8 (13.3)	2 (3.3)

MHS were followed.

Procedural Reliability

Two independent readers were trained to calculate T-units and MHS. The readers were trained to a 90% criterion level on T-units and an 80% criterion level on MHS using the 1987 Writing Supplement Project Basic Instructional Guide. The number of agreements was compared to the number of disagreements thus calculating interscorer agreement.

Design and Analysis

A pretest/posttest nonequivalent control group design with random assignment of treatment to groups was used (Campbell & Stanley, 1966). Teachers acted as their own controls in that each taught an experimental and control group. To determine if the groups differed significantly on the posttest across writing stages, a one way multivariate analysis of covariance (MANCOVA) was calculated. Univariate analysis of covariance (ANCOVA) was used to compare the pretreatment/posttreatment group means on two dependent measures: T-units and MHS.

Results

Omnibus Analyses for the Posttest and the Maryland Writing Test

Two indicators of writing were collected: T-units and MHS. These indicators were assessed pre and post treatment. To determine if there were significant differences between the groups across the stages of the writing process a one-way multivariate analysis of covariance (MANCOVA) was calculated for the posttest and the 1989 MWT. The means and standard deviations for the pretest and posttest and the 1988 and 1989 MWT are found in Tables 2 and 3 respectively. Results of the MANCOVA, using the Wilks Lambda exact F test, indicated a significant multivariate effect between groups on the posttest, F (5,49) = 14.02, p < .01. Results of the second MANCOVA, using the Wilks Lambda exact F test, indicated a significant multivariate effect between groups on the MWT 1989, F (5,49) = 53.60, p < .01. Collectively, the writing samples produced by students in the CWT on the posttest and the 1989 MWT were longer and of higher quality. Subsequent univariate analysis of covariance (ANCOVA) tests from the overall MANCOVA analysis were calculated. The results indicated that there was a differential effect across the stages of the writing process in favor for CWT. CWT were most beneficial for drafting and revising tasks. The results of the statistical treatments used on these data are described in the following sections: planning, drafting, revising, and MWT: Post hoc analyses.

Planning. A univariate analysis of covariance (ANCOVA) from the overall MANCOVA analysis was used to compare T-units generated during the planning stage of the posttest with the pretest serving as the covariate. The results indicated that there was no significant difference between the groups on the posttest, F (1,53) = 1.53, p > .05

Drafting. A univariate analysis of covariance (ANCOVA) from the overall MANCOVA analysis was used to compare T-units generated during the drafting stage of the posttest with the pretest serving as the covariate. The results indicated that there was a significant difference between the groups on the posttest drafting T-units, F (1,53) = 18.69, p < .01. The subjects in the experimental group produced a significantly greater number of T-units than the control group. The CWT also had a higher MHS than the C group on the posttest, but the results indicated that this difference was not statistically significant, F (1,53) = 2.04 ,

Table 2
Means and Standard Deviations of Different Study Writing Stage Variables for Each Group

	Experimental				Control			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Planning								
T-units	11.3	5.0	20.6	6.3	13.4	3.3	19.8	5.6
Drafting								
T-units	21.4	9.0	36.9	9.8	21.3	8.9	22.4	7.2
MHS	2.3	.7	3.1	.7	2.3	.6	2.7	.7
Revising								
T-units	24.5	9.4	51.6	6.5	24.2	11.2	29.4	7.1
MHS	2.5	0.7	3.9	0.2	2.5	0.6	3.4	0.6

$p > .05$.

Revising. Another univariate analysis of covariance (ANCOVA) from the overall MANCOVA analysis was used to compare T-units generated during the revising stage of the posttest with the pretest serving as the covariate.The results indicated that there was a significant difference between the groups on the posttest, $F(1,53) = 62.3$, $p < .01$. The CWT had a significantly greater number of T-units than the C group. The CWT also had a higher MHS than the C group during revising on the posttest, $F(1,53) = 6.98$, $p < .05$.

MWT: Post hoc analyses. CWT performed better on the posttest than the (C) group across two forms of The Maryland Writing Test (MWT) and across the stages of the writing process. For example, during the planning stage the CWT produced a significantly greater number of T-units than the C condition, $F(1,53) = 247.64$, $p < .01$. Likewise, during the drafting stage the CWT produced a significantly greater number of T-units than the (C) group, $F(1,53) = 62.9$, $p < .01$ and the CWT had a significantly higher MHS during drafting, $F(1,53) = 25.4$, $p < .01$. Finally, during the revising stage the CWT produced a significantly greater number of T-units than the (C) group, $F(1,53) = 8.8$, $p < .01$. However, with regard to MHS during revising there was no significant difference between the groups, $F(1,53) = 1.1$, $p > .05$.

Discussion

The results of this investigation suggest that CWT is an effective strategy which can increase the quantity and quality of writing. CWT create a positive inter-dependence among students and provide opportunities for peer interaction, social and academic reinforcement, and immediate grade gratification. A discussion of results concerns: (a) issues related to quantity and quality of writing, (b) differential effects of CWT across the stages of writing, and (c) implications for instructional practices.

Issues Related to the Quantity and Quality of Writing

CWT can significantly increase the length of student writing assignments. However, an increase in the length of writing assignments may not contribute to increased quality because length is not an indicator of quality. If the length of writing is a true indicator of the quality of writing, then MHS should have been statistically significant for the CWT during all stages of writing. Since this was not the case, it appears that the length of writing is not always an indicator of writing quality. Yet one additional factor must be considered in the interpretation of these results: the nature of MHS. The subjectivity of the qualitative instrument could have led to inconsistent results (Quellmalz, 1986; Quellmalz, Capell, & Chou, 1982).

Differential Effects of Interventions Across the Stages of the Writing Process

Planning. The results during planning were conflicting perhaps due to its independent nature. When students plan, they record everything that comes into their minds as fast as they can (Murray 1987); therefore, CWT may not be an effective stategy for planning because the characteristics associated with CWT are not the skills necesary for successful planning.

Drafting. During the drafting stage, CWT discussed, shared, and organized ideas which were generated. The specific techniques learned from other students in CWT may have been internalized by the students and transferred to the individual writing experiences. Considerable research suppports this explanation (Johnson, Brooker, Stutzman, Hultman, & Johnson, 1985; Johnson, Johnson, Roy & Zaidman, 1985; Smith, Johnson, & Johnson, 1981; Yager, Johnson, Johnson, & Snider, 1985). Although the resulting MHS were inconsistent, this fact could have been attributed

Table 3
Means and Standard Deviations of Maryland Writing Test for Each Group

		Experimental				Control			
		MWT88		MWT89		MWT88		MWT89	
Writing Stage		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Planning	T-units	17.2	12.0	37.9	5.2	10.8	5.12	16.2	5.4
Drafting	T-units	32.7	16.2	40.4	5.7	30.2	14.4	26.5	7.0
	MHS	1.9	.7	3.8	.4	1.9	.7	2.9	.69
Revising	T-units	34.0	14.6	40.9	5.5	31.7	13.8	36.2	6.5
	MHS	2.1	.8	3.8	.40	2.0	.7	3.6	.4

to the different topics.

Revising. The skills developed in CWT are essential to the revision process. In CWT, students serve as models for one another, assisting in the diagnosing and analyzing of problems, explaining the material to be learned to one another, keeping each other on task, and teaching concepts and procedures to one another (Johnson & Johnson, 1985). However, in the instance of the qualitative measures, the results were not consistent. There were significant differences for the posttest but no significant differences on the 1989 MWT. There is an explanation for the disparate results. During the drafting stage of the 1989 MWT, the mean MHS for the CWT was 3.8. The lack of significant group differences on the 1989 MWT may be attributed to a ceiling effect which occurred during the drafting stage of the writing process for the CWT.

Implications for Instructional Practices

The results of this study have several implications for practice. First, they support previous research efforts which indicate that cooperative learning can increase student performance (Johnson, Johnson, & Stanne, 1985; Slavin, 1984; Slavin, Madden, & Leavey, 1984). Secondly, CWT hold great promise for ameliorating the deficiencies of student writing. Specifically, CWT address the deficiencies which are characteristic of student writing: idea generation, text organization, and metacognitive strategies (Englert & Raphael, 1988). In addition, CWT use the principles of effective writing instruction (Isaacson, 1988). These principles include (a) allowing a sufficient amount of time for writing instruction and practice, (b) teaching writing as a dynamic process, (c) teaching writing through interactive group experiences, and (d) avoiding excessive teacher feedback. Finally, with the use of CWT, students diagnose and analyze problems and they explain concepts to one another; these are high-order thinking skills. When higher-order thinking skills are applied to writing, students can begin to to think more effectively as they write. In short, results indicate that CWT should be considered an effective instructional alternative.

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Teacher Teams Integrating Technology into the Mathematics/Science Curriculum

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This paper presents a successful model of a university-directed support for change in mathematics and science instruction using technology in several area school districts. Under an NSF grant, the author, as principal investigator, developed a three-year program involving five-person teams, composed of two middle school and two high school mathematics teachers and a non-mathematics teacher, from each of ten school districts. The non-math teachers had background and assignments in science, language arts, or social studies. The teaching faculty for the project included the author as lead instructor, three master teachers from area schools - two of whom were Presidential Awardees in Mathematics, and contributors from several fields: a mathematician with focus on applied mathematics and education professors with expertise in science education, social studies education, at-risk student populations, and change in schools. In addition, a professor of educational research and two doctoral students conducted the program evaluation.

In each of the three years, there was a three-week summer program and three Saturday sessions for updating and problem solving by teams, grade clusters, and individuals with similar concerns. The first summer was devoted to participant awareness of the mathematics reform effort with discussion and modeling of the NCTM *Curriculum Standards* (National Council of Teachers of Mathematics, 1989) and use of a range of technology - calculators, computers and key software. From the beginning, there was attention to the use of technology (appropriate calculators and computer software) and manipulatives as tools for instruction and student exploration in mathematics and its applications. Special attention was addressed to the concerns of instruction as addressed by Grouws and Cooney (1988) and literature on cooperative learning. The constructivist perspective was introduced and modeled with a focus on classroom discourse. Particular attention was addressed to the instructional issues around algebra as highlighted in Wagner and Kieran (1989).

During the first summer, participants worked each day on discrete mathematics topics with special attention on graph theory with some discussion of its applications for pre-college students. While a majority of the participants did not perceive this topic of value for their students during that first summer, many reported using it in their curriculum by the end of the project. From the start, calculators were a prime source of study. For the high school teachers, graphing calculators were the main item, however, many teachers spent considerable time on scientific calculators for reasons of availability in their schools. Middle school teachers learned about graphing calculators, but most spent their effort on scientific calculators and the Math Explorer. Despite the self-selection of the team members, many participants were not convinced that calculators should be used on a regular basis at the start of the program.

The second summer focused on appropriate classroom instruction with discussion of alternative models of instruction, as classified in Joyce and Weil (1986), and student assessment, as raised by Kulm (1990). There was consistent modeling of teaching via constructivism and with identification of its implications for the teacher and mathematics instruction (Davis, Maher, & Nodding, 1990). Participants examined materials, such as *Discovering Geometry* (Serra,1989) and versions of *Guidelines for the teaching of Statistics K-12 Mathematics Curriculum* (Burrill, 1991) as examples of such instruction. In the second summer, there was a continual return to technology, such as *Data Models* (Edwards, 1989) and instructional issues and skills developed earlier. Science laboratory activities were conducted using the Personal Science Lab from IBM with its data comparison graphs. Attention was devoted to school issues, student attributes, and classroom techniques for including at-risk students in the mathematics curriculum with technology and applications.

While participants had developed awareness and personal skills in dealing with technology, there was not much advancement in the use of technology in the classrooms during the first year, nor was much increase in individual use by participants reported. The participants reported acceptance of technology, but they had not internalized that technology into their instructional model nor their daily routine. This presented a concern to the principal investigator. However, during the second school year, there was a major increase in the number of participants who used technology in the classroom with their students and many participants reported acquiring their own computer and calculators. The acquisition and personal internalization of technology use continued throughout the duration of the project.

In the second summer, participants created sample units on topics of their choice. These units were done by teams of teachers, across schools, and presented to colleagues for review and recommendations. Time for the participants to create and revise these units was necessary and valued by the participants. In further discussion with them, it was noted that few of them had the opportunity to create lessons with their colleagues during their teaching careers. This collaborative effort during the summer was one of the most valuable activities as judged by the participants and project staff. The opportunity to have colleagues and faculty available as resources and reactors was important and well-used. This peer relationship developed quickly, with a few teachers being slow to accept some university faculty as equals.

In addition to their continued work with technology and instructional issues, the participants worked on staff development plans for their colleagues - at first their own school. Many of the participants eventually moved beyond this level to present mathematics inservice to mathematics teachers throughout the district, in neighboring districts, or at professional meetings of the Wisconsin Mathematics Council during the third year and beyond.

The third summer included intense study of the change process and varied strategies, such as indicated in Hall and Hord (1987). While the participants valued this aspect of the program, they noted that it might have been even more helpful if it had occurred earlier in their experiences with the math reform effort. This presents an interesting challenge of presenting issues of change before the teachers have a full set of materials and teaching strategies to share.

At the end of each summer program, the principal investigator formally invited each district superintendent and other appropriate district/school leaders to a reception with their team. Each reception started with the principal investigator reminding leaders of their signed commitment to the project and the accomplishments of the teachers up to that time. Each team then had over an hour to meet with the administrators to describe their work and to present their plans for the coming year and beyond. During each summer program, teams created district technology plans and staff development based on their professional growth. This effort was one of the strongest aspects of the program for the participants. They reported that they seldom, if ever, had the opportunity to report on their professional growth to district and building leaders or to present and receive feedback on recommendations for curriculum, pedagogical, and assessment change. This format was an important one for initating funding requests for technology needs. While this was initiated without knowing if administrators would show up in the middle of the summer, each year nine of the ten districts had representatives at the reception. A different district lacked representation each year.

From this interaction with administrators, the participants reported a more effective approach to making changes in their schools. In all cases they initiated, or were asked to prepare, requests for technology, manipulatives, resources, and/or textbook adoptions. Several of the teams requested inservice time to work with their colleagues and participate in professional meetings. Several teams made presentations to members of their school board. The teachers reported frustration at the end of the first year that not all of the administrators' promises were kept. For many, that was their first intense individual experience with the change process. Over the course of the project, they reported they learned the need to present their plans and requests followed by heavy lobbying efforts.

As in previous summers, there was new technology and materials to be considered. In the third summer, participants worked with the newly available NCTM *Teaching Standards* (National Council of Teachers of Mathematics, 1991a) and several of the Addenda series. The middle school teachers worked intensely with the *Patterns and Functions* (National Council of Teachers of Mathematics, 1991b) while the high school teachers worked with *Connecting Mathematics* (National Council of Teachers of Mathematics, 1991c) as a primary source. Several high school teachers worked together with the Geometer's Sketchpad (Bennet, et.al, eds., 1991) during the summer. Some of them were able to obtain the software for their school for the next year and taught geometry with the Sketchpad on a regular basis. Three of them gave presentations to colleagues at professional meetings on its use. Others expanded their knowledge of graphing calculators including gaining expertise in use of the TI-85, Sharp EL-9300, or Casio 7700. Again, numerous participants gave workshops in their schools, districts, and state meetings on the use of graphing calculators from middle school through high school.

The involvement of the non-mathematics teachers was very important to the project in several ways. First, they brought alternative perspectives to the topics of study and were instrumental in helping to find motivational, appropriate applications of mathematics for students. Three non-mathematics participants were lost over the duration of the project. Two withdrew during the first year because they did not view their participation as useful to their teaching responsibilities. On reflection, the first summer was heavily mathematical in terms of looking at reform, the use of technology and manipulatives. This focus did not do as much as could have been done to keep their involvement. Another non-mathematics person withdrew after the second summer because of a change in teaching assignment. Replacements and the original non-mathematics participants were valuable in criticizing their colleagues and project instructors when the material was too involved for students to pursue or lacked the interest or motivational values hoped for. The range of university faculty was important to provide participants support in bringing their backgrounds to bear on the mathematics reform efforts. The social studies and science applications were extremely valuable. Two teachers with language arts backgrounds were very powerful in dealing with communication as envisioned in the Standards. They contributed with techniques and lessons dealing with reading, writing, and oral presentation. They were helpful in refining techniques for cooperative learning settings. The non-mathematics participants were helpful in gaining recognition beyond the mathematics staffs in their schools.

The results of the project indicate many important considerations for schools involved in mathematics reform. First, the importance of time and on-going staff development and support is critical. The results of this study show major changes in teacher beliefs, skills, and implementation by the end of the third year. Such changes were not evident in many cases before that time. Changes in use of technology, both personally and for instruction, and appropriate changes in instruction based on the use of technology were particularly slow in coming. This issue is addressed in detail.

Another critical finding is the need to build a critical mass of individuals involved in the use of technology and focus on change. Where the teams functioned well, notable changes were observed. The functioning teams were instrumental in developing the mathematics reform across the middle and high school program. In most cases, this was not effective before the project. The connection of faculty between the two building levels must not be taken for granted. In all our districts, this project showed the great need for better articulation, grades 6-12. It also pointed out the equally weak connection between the elementary and middle school staffs.

Several teams were not as effective. In general, the larger the district, the less effective the team was in impacting district reform. The teams from the subdistricts of the large urban district had many more problems. Teacher re-assignment and turn-over in these schools made stability an issue - for teachers, administrators, and students. It was more difficult for the teachers to have an impact on policies or purchases. With a few exceptions, the individuals made far less impact on program, faculty, purchases, and change in mathematics instruction.

The university based program allowed the support of faculty with a wide range of expertise and skills. In addition to the principal investigator, with his background in mathematics and technology education, university faculty taught large units and/or served as resource faculty to participants throughout the project. Faculty with the following areas of expertise were involved: mathematics, particularly applied/discrete mathematics; constructivist learning theory; assessment; science education, social studies education; changes strategies; staff development; at-risk and under-represented students. In addition, the university coordination allowed the involvement of master teachers in the area with national credentials to participate on the program planning committee and serve as lead instructors and role models in the mathematics and pedagogy instruction. From the surveys of teachers, examinations of their logs, and observations in their classrooms, this mix of classroom teachers, known to them as area teachers, and the expertise of university faculty was highly successful in participant acceptance and willingness to try new instructional strategies and use of technology in the classroom and on student assessments.

This study demonstrated the intense attention required to help strong, dedicated teachers gain confidence and expertise in developing and delivering staff development to their colleagues. Many of the participants expressed fear and insecurity in preparing a worthwhile staff development program for their colleagues. When they gained expertise, they stated a strong concern that they had nothing to offer their colleagues, or more accurately on reflection, that their colleagues would not be interested in their presentations or ideas. Most participants found it much more comfortable to do presentations with at least one other colleague. This strongly supports the school change strategies advocated in peer coaching.

As the participants enter the first year without support, the need to have the participants support each other is very noticeable. Both the high school teachers across districts and middle school teachers across districts are seeking to keep the support groups they have had. Within districts, the middle school - high school connection is in danger without district support for continued sharing.

This report is an up-date of progress identified last year, (Kepner, 1993). Additional findings will be forthcoming as the classroom observations and teacher logs are analyzed in more detail.

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What Makes an Effective Computer Projected Presentation? Suggestions from the Audience

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Visualize for a minute the following situation. You have arrived at the room where you will be making your presentation, with your presentation software and file in hand. As you load your files on the conference provided computer, you notice that a cable to the Liquid Crystal Display is missing. After a frantic call to the "conference equipment manager", a new cable is provided, and you quickly install the Persuasion software, your file, and a few needed fonts. Although starting a few minutes late, you still have a full crowd for the session and even a few people standing at the door. You start your computer assisted presentation, and someone in the back asks you to dim the lights a little more so that they can see the text better. After eventually finding the light switch, the room is darkened and you proceed. To make sure you get in all the content you have to hurry your presentation, but no one seems to object and you proceed through each of the 50 "computer frames" of the presentation. Since you didn't have time for questions, you suggest that people can see you after the session is over, and with the exception of the one person who stops to ask the price of your presentation package, the audience files out with little comment and without any questions. As you pack up your disks, and delete your files from the conference computer, you ask yourself how the presentation went. Did the audience understand what you were saying about the topic? Did the computer projected presentation seem effective? If asked, what would the audience say about the presentation......and the presenter?

If you have ever used a computer presentation package in a formal presentation, you may have asked yourself some of the same questions. The use of computer presentation software, such as Aldus' Persuasion and Microsoft's Powerpoint, are becoming a more common choice for educators making professional presentations at educational conferences, meetings, and workshops. In fact, the overall market growth for such presentation software and related hardware is significant, and is projected to be over a billion dollars by 1995 (Todd, 1992).

Presentation software packages offer the presenter many advantages, including impressive graphics, easy to make handouts, and enhanced versatility of the presentation itself. The newest packages also provide significant multimedia related instructional advantages, such as more natural presentation of concepts through enhanced graphics, animation, and nonlinear navigation (Oblinger, 1992; Bayless & Clark, 1992; Kettinger, 1991). In the very near future, presentation packages should become increasingly more powerful in their speed, resolution, and ease of use (Head, 1992).

But there are also a few disadvantages to computer projected presentations, including potential equipment problems, the need for an extra dark room, and considerable setup time. Also, more impressive visuals are not always better in getting across a particular message. For example, a study by Livingston (1991) showed that color can actually be a distracting variable when teaching certain concepts in an instructional gaming environment. For international presentations, Sondak & Sondak (1991) found that presentation related graphics could contribute substantially to understanding, but only when the extensiveness of the graphic display was based on its purpose. Similarly, it would seem important for all users of presentation software to consider carefully the purpose of the displayed information to ensure that it contributes to the overall communication goal.

There seems little doubt that in today's technological world, computer projected presentations can be a powerful method of communicating with an audience. However, conveying a specific message is still the primary goal of any presenter, whether or not a computer presentation package is used to assist in this endeavor. The increasing general popularity of presentation packages, along with the related powers and limitations, suggests a need to redefine the characteristics of just what makes an "effective" presentation, and how to use presentation software to a presenter's maximum benefit in conveying a presentation message. As an initial step toward this goal, the authors decided to ask members of the "audience", people who are familiar with such methods of presentation, for their perceptions and suggestions related to using computer projected presentations more effectively in a large group setting.

An "Audience" Survey

A short open-ended survey was developed to ask various educators familiar with computer projected presentations, for their perceptions and suggestions related to using these software packages effectively when making presentations. The three part survey asked respondents first to remember computer projected presentations that they had seen in the past, and second to make a short list of the following:

1) At least three elements of computer projected presentations which seemed to increase the effectiveness of the presentation.
2) At least three elements of computer projected presentations which seemed to decrease the effectiveness of the presentation.
3) At least three general suggestions for presenters in making the computer projected presentation more effective.

The survey was distributed at several technology related meetings, workshops, and classes, with 65 educators initially responding by either mail or hand delivery, with additional responses currently being summarized. Although a more extensive analysis of a larger sample is being undertaken, some initial indications and suggestions from this pilot "audience" follows.

Elements Increasing Effectiveness

In general, the respondents seemed to believe that computer projected presentations were a very worthy tool that offered increased power to the presenter. Responses related to increasing the effectiveness of presentations tended to focus on the power of the package itself. Many respondents talked about the flexibility that such presentation packages offered, by making a presentation easily modifiable and reusable for different settings and purposes. Others commented on the ability to include graphics and sound, and the use of these advantages to help motivate the audience, and better "visualize" difficult concepts. Additional elements mentioned were the use of dynamic graphing and animation, to make a presentation "come alive" for the audience, or to review information in different ways. Still others talked about the ability to include CD-ROM and laserdiscs, and to access a "wealth" of real life examples and information related to a topic quickly when making a presentation.

Elements Decreasing Effectiveness

For elements from computer projected presentations that tended to decrease the overall effectiveness of the presentation, the respondents tended to focus on the actual human presenter, or the environment in which the presentation was made. For instance, the use of a very dark room, was often mentioned as a real problem. Respondents complained of "a voice from the dark" and the difficulty in taking notes, which often can result from using a Liquid Crystal Display. Other respondents cited situations where the presenter was unprepared for equipment failure, or unable to talk to audience members either before, during, or after the presentation due to their considerable involvement in equipment related tasks.

Some respondents complained of the difficulty in hearing or seeing a presenter who was sitting down behind a mountain of computer equipment, or who spent most of their time explaining the equipment or software, rather than the presentation topic. Various other responses cited problems with "information overload", in the form of either too much information for the presentation itself, or too much information on the individual slides or frames of the presentation. Although considerable problems were mentioned, an encouraging aspect of these general comments was that most of the audience-perceived problems might be fairly easily addressed by some very limited planning, or merely an increased attention to some general good presentation "fundamentals".

Suggestions for Improvement

The most "enlightening" part of the survey was the section requesting that respondents provide suggestions for presenters to improve their presentation. These suggestions were grouped into four main categories, including suggestions related to: 1) the presenter, 2) the presentation structure, 3) the environment, and 4) the equipment. Comments were well spread among these categories, with approximately 25% of the overall suggestions related to the behavior of the presenter, 35% related to the presentation structure, 19% related to the environment, and 21% related to the equipment. Here are ten of the more common suggestions, identified by category, given by this initial group of respondents.

Suggestion 1 (Presenter). Allow and be available for interaction. It is important for the presenter to greet and interact with the audience, and several of the respondents complained of the presenter completely ignoring the audience, usually by an intensive focus on the equipment, both before and after the presentation. Such basic audience interaction is essential for building rapport with the audience, and for determining their special interests or concerns with the topic.

Suggestion 2 (Presenter). Maintain eye contact with the audience. Good eye contact is very important when speaking to a group and there can be a real tendency by a speaker using a computer presentation package to sit down and talk to the computer monitor instead of to the audience. Sitting down and poor eye contact can both make it very difficult for the audience to hear and understand what the speaker is saying, and tends to make it more difficult for an audience to pay attention.

Suggestion 3 (Presentation). Use a good presentation structure. In any presentation, it is always a good policy to use a solid introduction, body, and conclusion structure. It is a bit like following the phrase of "tell them what you are going to tell them, tell them, and tell them what you told them". Several survey responses stressed the need for clear objectives and purpose for the presentation, and the use of a good solid communication structure.

Suggestion 4 (Presentation). Avoid "information overload". Information overload for an audience can be a real problem of a presenter using commercial presentation packages. It is so easy to use extensive graphics, text, and even animation, that often too much information is included in a presentation, or on each of the individual presentation slides. Using larger text, and limited words and graphics to convey the desired message will make the presentation more concise and much easier for the audience to follow.

Suggestion 5 (Presentation). Use good pacing. Presenters using a computer presentation package, may also tend to move from frame to frame too quickly, especially since this can happen with the mere touch of a mouse or keyboard, rather than the older necessity of replacing a transparency on an overhead transparency. Slowing down, and providing a short pause between slides, will help the audience keep up with the presentation and will give their minds more "processing time". This suggestion was a common one listed by respondents.

Suggestion 6 (Environment). Don't make the room too dark. The most common of the respondent suggestions was related to making the room light enough to take notes, and to avoid the "voice from the dark" situation for a presentation. One suggestion emphasized using an additional overhead projector focused on the back wall or ceiling of the room to increase lighting if needed without using the overhead lights. A totally dark room can also "over-relax" an audience, and make it difficult for them to pay attention to presentation specifics for an extended period of time.

Suggestion 7 (Environment) Fill the screen with the projected display. Another very common suggestion in making it easier for the audience to actually see the presentation visuals was to make them larger. In particular, the typical "speaker table" setup usually found at conferences has the overhead projector and LCD too close to the screen for an appropriate focal length. Thus the presenter may need to move the equipment back far enough to make a large readable picture for the full audience. The use of a large amount of computer equipment by a presenter may also suggest considering a different overall room setup (for example, providing a larger aisle in the middle of the room), so that everyone can see both the visuals and the presenter.

Suggestion 8 (Equipment) Be prepared for equipment failure. Murphy's law says that "whatever can go wrong will go wrong" and for some reason this seems to be the rule rather than the exception when using computer equipment in front of a large group of people. It is essential to have a backup plan of some type when using a computer projected display. A good backup plan may include some standard overhead transparencies, 35 mm slides, or basic handouts, all of which are easily facilitated with most commercial presentation packages.

Suggestion 9 (Equipment). Double-check your equipment ahead of time. When possible, it is also a good idea to run through the presentation at least once before presenting it. This is especially true with conference provided equipment, which may have different system software and fonts than those the presenter usually uses. Since time is often limited before a session, it may be helpful to bring an external hard drive with an intact system, or use the more common fonts and text styles available, to help avoid the necessity of last minute changes to a presentation file.

Suggestion 10 (Equipment) Focus on the message and not the equipment. It is always important to remember that unless demonstration of the equipment is actually the topic, people are usually attending a session to hear about an educational topic rather than to hear about equipment and software. One respondent stated this concisely, if not a bit too strongly, by suggesting "present your concept, and not your technology toys". Being topic focused, and to the point, is often appreciated by the audience, and may help leave additional time for questions at the end of the presentation.

Conclusion: All Presentations are Human Endeavors

Perhaps the most interesting aspect of what we found from this initial survey, is the relationship between the human and the technology elements of a computer projected presentation. Even with the powerful new capabilities of commercial presentation packages, professionals still tend to view such presentations as primarily "human endeavors" that succeed or fail based on human rather than equipment considerations. There was very little criticism of the presentation packages themselves, and no one suggested that a presentation would be stronger without using one. Most suggestions tended to reinforce that a presentation really rests on more basic and fundamental considerations, such as good speaking skills, good structure, and a clear concise message. As with most applications of technology to education, the presentation package is merely a tool to help get the job done, although it can no doubt be a very powerful tool.

Based on the feedback from this pilot "audience", a presenter using a computer presentation package, like any presenter, needs to be especially aware that the audience is present first and foremost to hear a professional colleagues' perceptions of a topic or issue, and that the presentation format itself should assist, rather than detract, from that purpose. Computer presentation packages can no doubt lend powerful assistance to conveying a presentation message, as long as they are used in context of the overall purpose. The general policy of letting the curriculum drive the technology rather than the reverse, often cited by current educational technology thinking, would seem to be a good rule for using technology in professional oriented presentations as well.

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The Network University Lectures Concept

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The aim of this paper is to present work on a concept for giving lectures in a distributed computing system dedicated for distance studies.

The Network University concept is based on a dedicated distributed computing system. It's main components are a student's workbench, a lecturer's workbench and several servers, which are interconnected by a computer network based on public communication services. The concept of giving lectures within this environment integrates Computer Mediated Communication (CMC) with Computer Aided Instruction (CAI).

Although use of CMC and CAI in education are both state of the art, systematically integrating them for these purposes seems to be a new field of study. The Network University concept addresses the problems observed by the scientific community with isolated use of either CMC and CAI. These problems result in part from neglecting issues of Human Computer Interfaces (HCI) with the "traditional approach".

Introduction

The Network University Lectures Concept is part of the Network University project. This project aims in providing means for reorganizing courses and lessons of a traditional university curriculum in such a way that only part takes place on campus while most of the time students work at home with a dedicated student's workbench. This approach tries to combine benefits of a traditional university curriculum with those of a distant study approach.

Students of traditional universities benefit from the community of students and faculty such universities provide. This community enhances communication of students one with another and of students with faculty. Modern learning concepts, such as cooperative learning take place on traditional universities implicitly, if not within lectures and courses, then with self organized student learning groups. Drop out rates with traditional universities, though high, are lower than those with their distance counterpart.

Distance learning is considered to be a cost effective alternative to traditional universities. In addition, distance learning addresses a target group which cannot be addressed by traditional universities. According to Morton Flate Paulsen (1993) distance learning offers six freedoms: curriculum, space, time, access, medium and pace. These freedoms allow people to attend courses, who would not be able to study on traditional universities for reasons based in lack of one or more of those freedoms.

The basic idea of the Network University Concept is to use computers and computer networks to deliver university services to the student's home. Lectures are such services.

The lesson type of a lecture is attuned to transfer knowledge from the lecturer to students. According to this goal, most communication in lectures is the monologue of the lecturer. Students were asked to estimate the percentage spent in lectures with monologue, dialogue and discussion. Their estimates averaged in 90% monologue, 7% dialogue and 5% discussion.

CAI can be used to a large extent to surrogate a lecturer's monologue. Dialogues and discussions can be made possible at a distance by means of CMC. This research project aims in proving these assumptions and in implementing a prototype of a distributed computing system tailored for this application.

Computer Aided Instruction

As CAI is concerned, its value for teaching is well known. As early as 1968 the ALCU project proved that it is possible to improve learning efficiency with CAI (Seidel & Lipsmeier, 1989). An improvement of needing 30% less time for learning a specific subject with CAI than with traditional classroom teaching was achieved. More recent studies explore this in more detail, however they confirm that students can learn better with CAI than with traditional courses (Burnes & Bozeman, 1981; Kulik, Kulik & Cohen, 1980; Kulik, Bangert & Williams, 1983; Hasselbring, 1986; Sageder, 1993). As Hasselbring (1986) observed, CAI in particular enhances the learning success of students who learn successfully anyway. However the studies mentioned above point out that for optimal results, use of CAI has to be complemented by interaction and communication. They recommend group work and discussions about the subject learned with CAI. More recently Sageder (1993), Moore (1991), and Fulford & Zhang (1993) reaffirm the importance of communication and interaction when learning is isolated.

Computer Mediated Communication

CMC provides means for communication without the need of physical meetings. From that point of view it seems to fit well the needs of distance learners. Especially when using CAI, use of CMC for communication seems to be a natural extension. However the state of the art of using of CMC for education seems to be to use it without regard to CAI. Many recent distance courses of different kinds have been using CMC (Bateson T,1992; Goldman, 1992; Kearsley & Lynch, 1991; Kemp, 1992; Kendell & Oaks, 1992; Koschman, 1992; Levin, 1992; Paulsen, 1991a; Paulsen, 1991; Philips, Santoro & Kuehn, 1988; Riel, 1992; Roschelle, 1992).

The experiences resulting from these courses show that CMC can be used successfully to implement several interactive and cooperative educational methods with success. In particular cooperative learning with CMC is reported to be more successful than traditional lessons. Students' motivation and diligence is enhanced with these educational methods compared to traditional classroom learning (Bateson, 1992; Compostella & Sligte, 1992; Hawisher, 1992; Hansen, Chong, Kubota & Hubbard, 1993). However use of CMC may result in typical problems: Students may be aware of using it or they may have problems with the complexity of standard CMC user interfaces. Paulsen (1991a) points out that when concentrating on dealing with CMC user interfaces, the student may withdraw the focus of attention from the subject of learning.

The Network Universities Lectures Concept

The Network Universities Lectures Concept applies CAI programs for presentation of subject matter while using customized CMC for providing means for communication between lecturers and students and for discussion. Supporting communication does not only provide means for dialogues and discussions but also provides means for complementing CAI with communication as considered necessary by Seide (1989), Moore (1991), Fulford (1993),and Sageder (1993).

To overcome students problems with use of CMC, suggested by Hansen (1993), Paulsen (1991), Kearsley & Lynch (1991), this project concentrates on the Human Computer Interface. In computer science it is well accepted that the Human Computer Interface is a critical factor for users ease or problems in using their computers. If learners have problems with using CMC when learning at distance, one might question whether the CMC systems in use are appropriate. Checking appropriateness in this context means whether the functions provided meet the functions needed and whether the functions needed are provided in a way that matches the user's intuitive expectations.

Communication and Communicative Actions

A way for analyzing appropriateness of tools is to compare the steps needed to accomplish a task with a tool with the steps intuitively expected to be necessary for accomplishing this task by the user. One example is use of electronic mail as a tool for communicating with the lecturer.

To accomplish this task, the learner has

1. to switch from the CAI program to the electronic mail program which often is partitioned into
   -1.1 leaving the CAI program.
   -1.2 activating the electronic mail program
2. to remember and supply the electronic mail address of the lecturer

3 type in the question
4 leave the mail program
5 switch back to the CAI program

In the classroom environment, the learner only has to catch the lecturer's attention and to ask the question. These are the steps the student expects intuitively to have to perform for asking a question. For simply hearing answers and discussion contributions, the learner does not need to start any action in a classroom environment, but with CMC has to activate the appropriate programs.

This simple analysis illustrates that general CMC systems are communication tools, which offer a user interface requiring activities, that are strange when compared to the intuitive expectation of what is to be done. However, for the functions provided by those tools all these actions are necessary. This situation will not change significantly just by thinking about a better user interface for CMC.

Now, are all the functions, which CMC offers needed in the Network Universities Lecture context? At the first glance, yes. Interpersonal communication provided by electronic mail and the group communication services are needed. However, are they needed to the extent, that they are offered? Here, the answer is no.

The learner, when learning a course topic, does not need to communicate with any person or group reachable over a network using arbitrary CMC services. What the learner needs, is support for communicative activities arising from attendance to a network course. Concentrating on such activities can restrict the functions needed from the communicative system and hence redesign the user interface to be more attuned to the situation.

Communicative activities supported this way or a similar way are:
-asking questions about subject matter,
-discussing subject matter,
-chatting with pals,
-communicating with lecturers about administrative concerns,
-implicitly gathering information about the students, learning success and,
-guiding students' learning.

For these activities the addresses of communication partners and discussion groups can be fixed in such a way that they may not have to be supplied by the user anymore.

To make switching between CAI and CMC easier, they are integrated into a single user interface which enables the student to perform learning tasks and several communicative actions. Instead of explicitly switching to CMC, the student launches a communicative action such as asking a question or joining a discussion. Use of CMC is implicit and transparent to the student.

The Impact of Course Structure for Communication

CAI courses are not implemented as monolithic programs, but are structured into chapters, subchapters, and topics. When assembling a CAI course, the lecturer arranges which discussion group is appropriate for discussing the subject matter of a topic or a chapter. In the same way the lecturer arranges which tutor is in charge of answering questions to a topic or a chapter.

The system keeps track of these structure when a student works with CAI. Thus, when a student launches a communicative activity, the system "knows" which topic the student was working with, when he launched that activity. From this information it identifies which discussion group is to be used for discussions or to which tutor questions are to be sent. The student has only to deal with the topic. The focus of attention stays with the subject of learning. Answers and other messages are presented at the time they match the subject being learned. So even answers and messages do not remove the student's focus of attention from the subject.

The User Interface

The user interface is based on MS-Windows, allowing the user to launch actions just by "clicking a button". With the student workplace, buttons for communicative activities are permanently at the top of the screen, regardless of which program is running. Thus a student at any moment can launch a communicative action by clicking the appropriate button. Receiving communication items is done automatically. Messages and replies to questions are presented automatically, when the student enters the topic again, where the message belongs or where the question was asked.

This approach provides interaction and communication necessary for complementing CAI for achieving optimal results. At the same time, it eliminates student's problems with CMC interfaces and distraction of the student's focus of attention from the subject of learning. This is done by replacing complex CMC user interfaces by simple facilities for performing communicative actions such as asking questions or discussing on a per subject basis.

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NCATE Standards and Technology Education

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NCATE is the National Council for Accreditation of Teacher Education, the foremost teacher accreditation agency in the United States. Since the International Society for Technology in Education (ISTE) has become a specialty organization under the NCATE umbrella, certain techology-education folios should be written as preconditions to an NCATE visit. Colleges seeking new and continuing NCATE accreditation for their education units will be required to meet new standards that include broad use of technology in teacher preparation programs. NCATE's standards address four categories: I. Curriculum of Professional Education, II. Candidates in Professional Education, III. Professional Education Faculty, and IV. The Unit for Professional Education. Within the categories are standards; these are further refined into indicators.

In June 1993, Arthur E. Wise, President of NCATE, circulated a Draft of the Refinement of NCATE Professional Accreditation Standards with an invitation to use it for focus discussions at professional meetings. NCATE has come to the realization that technology in education is here to stay and that teacher education programs without technology are lacking in very fundamental areas. Within the very limited space alloted is an overview of the places in which technology impacts proposed NCATE standards.

Proposed Technology-related Standards

Of particular interest to participants in the Technology and Teacher Education Conference are those standards and indicators that directly address the uses of technology in the teacher education process. In order to focus on the roles that technology will play in this process, each related standard is presented to provide a frame of reference and the technology emphasis is in italics. NCATE assumes that each unit will interpret the indicator in terms of its own needs and programs. The text excerpts that follow were taken from the proposal document (NCATE, 1993).

Standard I.A-3: Content Studies for Initial Teacher Preparation (Initial). Indicator 5 states, " Content studies provide candidates with a well-planned sequence of courses and experiences that develop an understanding of the structure, skills, concepts, ideas, values, facts, methods of inquiry and uses of technological tools for the subjects they plan to teach.

Standard I.A-4: Pedagogical Studies for Initial Teacher Preparation (Initial). Indicator 8 includes two new technology components. "The professional studies include knowledge and appropriate experiences with: (a) the social, historical, and philosophical foundations of education, including an understanding of classrooms and schools as social systems and the impact of technology and societal changes on schools; (f) educational computing, including the use of computer and related technology in instruction, assessment, and professional productivity". Indicator 9 states "The pedagogical studies for the initial preparation of teachers provides knowledge about and appropriate skills in .... instructional strategies, including the use of instructional technology;...".

Standard I.B-1: Quality of Instruction (Initial and Advanced). Indicator 19, a totally new criterion, states

"Instruction reflects knowledge and use of various instructional strategies and technlogies".

Standard II.C: Monitoring and Assessing the Progress of Candidates (Initial and Advanced). Indicator 37 has been *expanded to include, "Assessment of candidates' progress is* based on multiple data sources including grade point average (GPA), observations or videotapes of performance of applications of various instructional strategies and technologies,...".

Standard III.A: Faculty Qualifications (Initial and Advanced). New indicator 45(b) states," Faculty model the integration of computers and technology in their field of specialization."

Standard IV.B: Resources for Teaching and Scholarship (Initial and Advanced). Indicator 67 states, "Faculty and candidates have training in and access to education-related electronic information, video resources, computer hardware, software, related technologies, and other similar sources".

Standard IV.C. Other Resources for the Unit (Initial and Advanced). Indicator 73 states, "Facilities and equipment support education communication and instructional technology needs, including computers, and they are functional, and well-maintained."

Impact for STATE Members

The recognition of technology components in the accreditation process has many significant implications for teachers of technology-based learning. Most importantly, these standards and indicators reflect the acceptance of educational technology as a fundamental part of the teaching, learning, assessment, evaluation, and productivity processes. They give credence to the importance of technology across the grades and curricula, to the need for teachers with a wide-range of technology skills and concepts, and to the need for teacher-educators who will remain on the cutting edge of educational technology.

Senior faculty, even those who may be responsive to technologic innovation, may be unwilling to invest the countless hours required to redesign their lectures and modes of teaching. Just as technology has provided the tools for creating a seamless curriculum (Abramson, 1992), it has similarly stimulated a need for revamping and interconnecting courses. Many units will create opportunities for subject-specialty faculty to team-teach with technology-specialty faculty. The standards and indicators provide guidelines for the development of learning communities within the professional sequence program.

At last, technology in teacher education is gaining recognition within the profession. Much of the credit for our "coming of age" is a function of the excellent work done by the ISTE Accreditation Committee, based upon feedback from all of us. Let us act upon our newly-found strengths and use technology to raise educational achievements to previously unattainable levels.

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A Model for Using Anchored Instruction in Preservice Educational Technology Classes

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Anchored instruction is a model that emphasizes the creation of an anchor or focus around which instruction can take place. It is defined as, "A focal point or problem situation that provides [a link] for students' perceptions and comprehension" (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990, p. 123). McLarty, Goodman, Risko, Kinzer, Vye, Rowe, & Carson (1990) expanded on this definition by adding that anchored instruction is, "A rich shared environment that generates interest and enables students to identify and define problems while they explore the content from many different perspectives" (p. 2). This instructional model helps alleviate the problem of inert knowledge—the type of knowledge that people can recall when prompted, but cannot recall spontaneously during problem solving (The Cognition and Technology Group at Vanderbilt, 1990).

Often in educational technology classes designed for preservice teachers, the knowledge and skills students acquire are inert. For example, students may learn the mechanics of operating desktop publishing software; however, they have difficulty applying their knowledge of desktop publishing in their own teaching activities because of the way in which the topic was presented to them originally.

There are two major reasons for incorporating anchored instruction as a model for an educational technology course for preservice teachers. First, researchers feel that such an approach lends itself to teaching preservice teachers how to use a variety of technologies. Students can construct projects centered around the anchor using various technologies. Since the anchor can be tied to real world events, the problem of inert knowledge can be avoided. Second, the anchored instruction model is one that the preservice teachers can transfer to their own teaching. It is a model that can be applied to any grade level or content area, and could be used to integrate content areas. The anchor can serve as both a context within which they can practice what they have learned about a single technology, as well as a common thread with which a number of technologies can be sewn together.

Researchers investigated how anchored instruction could be used to teach educational technology courses to preservice teachers at the University of Northern Colorado (UNC) by designing a course based on McLarty's (1990) seven key decision points in anchored instruction. Researchers borrowed five of McLarty's decision points and added one of their own. They were, respectively:

- Choosing an appropriate anchor
- Developing shared expertise around the anchor
- Expanding the anchor
- Teaching with the anchor
- Allowing student exploration
- Sharing what was learned from the anchored instruction

Researchers were interested in determining the extent to which students could apply the model from the viewpoint of a teacher once they had participated in anchored instruction as a student. The following sections discuss how the educational technology course was designed using anchored instruction following the six key decision points.

Choosing an Appropriate Anchor

The first task in designing a course using anchored instruction as a model is to choose an appropriate anchor. Computer simulations, films, videos, and printed materials all can be used as anchors (Cognition and Technology Group at Vanderbilt, 1993). But the key to selecting a good anchor is that it should be capable of supporting multiple disciplines, and it should be rich enough to support problem solving (McLarty et al., 1990).

For the preservice educational technology course at UNC, the popular computer simulation *Oregon Trail* was chosen as the anchor. Researchers felt that it met the criteria for a good anchor because it could stimulate thought in a variety of disciplines including math, science, history, geography, and language arts. Additionally, many projects could be designed around this anchor that required students to use various technologies.

The *Oregon Trail* simulation is also rich enough to support problem solving. For example, students could collect data along their vicarious *Oregon Trail* journey such as distance between landmarks, number of days it took to travel between two landmarks, the daily temperature extremes, and so on. This data could then be entered into a spreadsheet along with data from other students in the class who participated in the simulation. Formulas could be constructed to compute the average speeds of the various wagon trains. Students could then extrapolate the data and make inferences to answer questions such as:

- Did the daily temperatures influence the speed at which the wagon trains traveled?
- Did the occupations of the wagon train leaders influence how many people in the various wagon train parties successfully reached Oregon?
- Did the time of the year in which the wagon trains left Independence affect the number of people who successfully reached Oregon?

These and other questions could be constructed by the students. This is just one example of how the *Oregon Trail* simulation supported a rich, problem solving environment.

Another consideration when selecting the anchor for the preservice educational technology class was whether or not the anchor would maintain the students' interest. The year 1993 marked the 150th anniversary of the *Oregon Trail*, and local press coverage of activities surrounding the anniversary was quite extensive. Several students cut out related news stories from the local newspapers and videotaped television specials for use in their projects. Since there was much regional interest in the *Oregon Trail* during 1993, this choice of anchors turned out to be better than researchers initially expected.

Developing Shared Expertise and Expanding the Anchor

By participating in the computer simulation *Oregon Trail*, students naturally began to develop a shared expertise around the anchor. To ensure that student experiences with the simulation were not merely superficial, researchers encouraged critical viewing skills by having students keep a detailed record of places visited, dates, and other details. The next step was to develop this shared expertise further by expanding the anchor. The key element in this process was library research that made use of a variety of technologies including on-line databases and CD-ROM resources. Again, problem solving skills were essential to finding the information necessary to produce the various projects related to the anchor. For example, one of the projects required students to construct a newsletter based on some location along the *Oregon Trail* using desktop publishing software. Students were assigned a landmark and were asked to research that location and write stories about it. Some of the locations were quite obscure and required creative search strategies in order to obtain information.

Researchers have since added a workshop on developing search strategies, using CD-ROM library catalogs, and using on-line databases and e-mail through the Internet. These additions to the preservice educational technology course were designed to aid in the expansion process. This was necessary because many of the preservice teachers did not have adequate prerequisite skills that would allow them to make effective uses of such resources.

Teaching With the Anchor

Once students had developed a shared expertise and had expanded the anchor by conducting their own research, many different technologies (innovations) could be taught using the anchor. Instruction on the use of these innovations usually involved workshops where students first learned the basics by way of direct, hands-on instruction. They were then assigned a project related to the anchor that made use of the innovation. The following projects are examples that illustrate this process.

Word Processing Project. Students imported the *Oregon Trail* "Trail Log" into Microsoft Word 5.1 and made use of the various editing features to write letters home from the trail based on these "Trail Logs."

Drawing Project. Students used the popular Claris MacDraw application to illustrate a scene from their "Trail Log." The drawings were then exported to a variety of other documents.

Spreadsheet Project. Students constructed a spreadsheet based on various data (e.g., dates, distances, amounts of money) collected during the *Oregon Trail* simulation. They manipulated and extrapolated this data in order to draw inferences and construct relationships among variables.

Scanning Project. Students gathered pictures from books, journals, newspapers, etc., and scanned these images using a flatbed scanner. These images were then processed using Adobe Photoshop and MicroFrontier Color It! to be used in the Desktop Publishing and Presentation Projects.

Desktop Publishing Project. Students combined elements from the Word Processing, Drawing, and Scanning Projects to create a newsletter based upon some location along the *Oregon Trail*.

HyperCard Project. Students designed HyperCard stacks that presented information about the *Oregon Trail* location that they had been assigned to research. In the future, researchers will form "expert groups" who gather textual and graphic data on a facet of the anchor. Each expert group will be responsible to make a stack; all stacks will then be integrated into a large stack and shared among all class members.

Presentation Project. Students were asked to design a presentation using Aldus Persuasion that illustrated how they could use the *Oregon Trail* anchor to teach something in their content area. These presentations were shared on the last day of the semester.

Before anchored instruction was adopted as a model in the preservice educational technology course, all of the topics listed above had been taught as discreet workshops. The projects that went along with the workshops were unrelated to each other and had very few guidelines. For example, students would be given instructions on how to use spreadsheets and then asked to design a spreadsheet based on something that interested them. The results were often less than satisfactory with students completing the projects by doing the minimum amount of work required. When the *Oregon Trail* anchor was introduced in the Summer Semester, 1993, researchers noted a remarkable difference in the quality of the projects submitted. Students took much more pride in their finished projects and commented frequently how helpful it was to have a theme on which to base these projects. In all, teaching with the anchor was very natural and resulted in enhanced student performance on the required projects.

Allowing Student Exploration

In one section of the preservice educational technology course, five students were selected to participate in a special multimedia project related to the *Oregon Trail* anchor. These students were asked to gather materials that could be incorporated into an interactive video program. Researchers provided scaffolding by writing applicable HyperCard scripts and connecting the necessary hardware which freed the students to design and develop their project. One student explored the role of minorities in the Westward Movement of the mid-1800s. He visited a museum exhibit in Denver devoted to Black Cowboys and produced video clips based on this information for use in the multimedia project. Another student looked at how Hollywood has stereotyped individuals who helped settle the West. He compared Hollywood's vision of the Western hero with a more realistic vision through the use of video clips from *Jeremiah Johnson*, *Stagecoach*, and other movies. A third student engaged in further exploration of the anchor by interviewing a local historian who specialized in animal traps used by fur traders during the mid-1800s. She videotaped a visit to this historian's museum and incorporated this documentary material in the multimedia project. The whole process of design, videotaping, and writing the applicable HyperCard scripts to display live video turned out to be very labor intensive for both students and instructors. However, researchers concluded that multimedia projects are a terrific way to get students to engage in exploration of topics related to the anchor.

Other students who were not involved in the special multimedia project also explored topics related to the anchor. Many were able to combine their own interests in areas such as music, art, and engineering while producing the projects outlined earlier.

Sharing What Was Learned From the Anchored Instruction

Finally, students were asked to share their projects. In doing so, they gained valuable insight into various creative processes present among individuals in the class. The process of sharing also created a sense of pride among students—especially when they shared their desktop publishing and presentation software projects. Bransford et al. (1990) noted that students find the creation of multimedia projects highly motivating, in part because of the professional look of the results. They conjectured that the professional look increases audience interest and therefore the quality of audience feedback during presentation. By contrast, other researchers have discovered that students designing multimedia projects were more interested in pleasing themselves and other members of their collaborative groups than trying to impress an outside audience (Carver, Lehrer, Connell & Erickson, 1992). In the preservice teacher technology course, there was a sense of friendly competition among students when they showed off their use of color, special effects, graphics, creative uses of scanned images, and so on during the last class meeting. Researchers observed that students were very proud of what they had created. In all of these cases, the opportunity to develop a "presentation-quality" product provided strong student motivation.

Results of Using Anchored Instruction

Researchers were interested in determining whether using anchored instruction would lend itself to teaching preservice teachers how to use a variety of technologies, and the extent to which students could apply the model from the viewpoint of a teacher once they had participated in anchored instruction experience. A variety of data were collected including:

- Videotaped observations of students working on projects
- Videotaped interviews with selected students
- Documentation in the form of student produced projects
- Information provided by instructors

Students did learn how to incorporate a variety of technologies using an anchored instruction approach. Clearly, the student projects demonstrated that they were quite competent at using word processing, spreadsheets, drawing programs, desktop publishing, and other innovations. Students also mentioned in interviews that, while at first many of them were very apprehensive about their ability to learn some of the more complicated programs, by the end of the term they were very comfortable with even the most complex applications. Data provided by the instructors supported these claims.

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The second research question—whether students could apply the anchored instruction model in their own teaching—is more difficult to determine. Most of the students interviewed mentioned that they understood the model and felt it was very worthwhile to learn. Several said that they planned on applying a similar approach in their own teaching. However, exposure to this model in a single two semester hour course is not likely to make a great deal of difference in the long run. A longitudinal study would be needed in order to determine whether exposure to the anchored instruction model had any impact on the student participants in their own teaching.

Researchers noted several advantages and disadvantages in using anchored instruction to teach preservice educational technology classes. Advantages included:

- Preservice teachers developed a richer understanding of integrated curriculum
- Preservice teachers who participated in the anchored instruction course planned and produced better quality projects than those who participated in a context-free section of the course
- Anchored instruction facilitated cooperative learning

Disadvantages included:

- Preservice teachers exhibited problem solving deficiencies
- Anchored instruction was labor intensive
- Preservice teachers expressed concerns about having access to similar technologies when they leave the university

One continuing problem that researchers observed from the use of an anchored instruction approach was role confusion on the part of the preservice teachers. During the anchored instruction process, they were asked to play the role of students, producing projects as their own future students would. In this way, they could observe teachers (the researchers) modeling anchored instruction firsthand. However, in the presentation software project, they were asked to turn around and imagine how they would apply this model as a teacher in their own classroom. This was designed to assess whether they understood the model and could use it in the classes they would teach. Researchers noted some confusion on the part of the preservice teachers related to this change of roles.

For Further Research

Using anchored instruction to teach preservice teachers educational technology appears to have worked well. However, many questions emerged from this initial investigation. Specifically:

- Can students apply this model in their own teaching?
- Does an anchored instructional approach enhance student learning of technology applications in the classroom?
- Are there unique outcomes from using anchored instruction that researchers have not anticipated?
- Does using anchored instruction influence student attitudes toward the use of computers in their own teaching?

These questions will require further study in future sections of preservice educational technology classes.

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A Technology Enhanced Approach to Special Education Personnel Preparation

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Currently, reform is the clarion cry in teacher preparation. Commissions, legislators, and educators are calling for reforms in teacher preparation programs. Despite the ongoing discussion regarding the need for educational reform in higher education, relatively little attention has been focused on instructional improvement. While the role of technology in facilitating fundamental change in education is often cited, it appears that most reform efforts to-date have neglected to utilize information technologies as integral components of school improvement activities.

Doyle (1990) argues that several important conceptual and methodological directions are emerging from the intellectual turbulence in teacher education that should help enhance the future of teacher education. The first is a broadening of the intellectual foundations for teaching and teacher education beyond educational psychology, which focuses on teacher behavior, to other disciplines that focus on understanding contexts. Second, he suggests the use of alternative sources of information from the content field, cognitive studies, and research on pedagogical-content and enactment knowledge that are much richer than process-product findings for conceptualizing practices. Third, new understandings emerging from classroom research clearly suggest that practical teaching knowledge is interpretive and/or procedural rather than simply prescriptive. That is, useful knowledge enables teachers to build on their repertoire of instructional and management skills to: (a) understand classroom curriculum, management, and instruction events so that instructional practices can be selected that fit specific classroom situations, and (b) know how to carry out a practice in typical teaching contexts.

Advances in multimedia technology allow teacher trainers to use video to enable students to explore multiple classroom environments (Abate, 1992; Goldman & Barron, 1990). They can view multiple instances of expert teachers modelling effective teaching behavior and solving academic and social behavior problems. The goal is to create instructional anchors that provide shared information that can be used to develop knowledge about problem solving skills and effective teaching strategies (Cognition and Technology Group at Vanderbilt, 1990). Using multimedia in conjunction with anchored instruction allows the creation of shared environments that permit sustained exploration by students to enable them to understand the kinds of problems and opportunities that expert teachers encounter and the knowledge these experts use as tools. However, the technology itself is not a vehicle for the acquisition of skills or the construction of knowledge (deCorte, 1990; Elliott, 1985; Papert, 1990; Salomon, 1990). Rather, skill acquisition and knowledge construction is embedded in a rich and developmentally appropriate teaching-learning environment.

The Technology Enhanced Teacher Training (TETT) project was designed in response to the call for increased quality and alternative approaches to teacher preparation (Hawley, 1988; Holmes Group, 1986), the need for additional empirical information regarding teacher preparation (Houston, Haberman, & Sikula 1990), and the emergence of technology as a powerful teaching tool (Cognition and Technology Group at Vanderbilt, 1990; Rieth, Haus, & Bahr, 1989). The purpose of this federally-funded special project is to develop, evaluate, replicate, and disseminate an exemplary technology enhanced undergraduate and graduate teacher training program that incorporates the most recent advances in multimedia and video technology, cognitive psychology, teacher behavior research, teacher training research, and behavioral technology.

Technology Enhanced Teacher Training

The project focuses on restructuring teaching and learning in the college classroom through the use of multimedia technology. It addresses a major impediment to the use of technology to restructure instruction and learning in higher education: the absence of accessible easy-to-use software tools and content resources to integrate technology applications into their courses.

To address this impediment, the investigators are developing a powerful, flexible, and integrated software system called, *Teaching Assistant*. A critical design feature of *Teaching Assistant* is that it will serve as a multimedia shell for integrating a number of off-the-shelf products which have been specifically selected to enhance two dimensions of faculty productivity: professional and instructional (Gardner & Edyburn, 1993). This approach provides faculty members with a toolkit of software programs (multimedia, word processing, database, spreadsheet, telecommunications, graphing/drawing, desktop publishing, and presentation) that contributes to professional productivity while simultaneously supporting new forms of instructional presentation. As a result, by integrating a number of separate classroom functions, *Teaching Assistant* serves as a hybrid product that provides college faculty with the necessary tools to use technology in support of their efforts to enhance teaching and learning. Specifically, the software program will be composed of four categories of tools.

Components of *Teaching Assistant*

The first component of *Teaching Assistant* is Teaching Tools. This component involves four types of tools. A Presentation Manager serves as a simplified authoring system to facilitate the development and integration of textual information and videodisc material. The conceptual foundations which guide the development in this area are found in the effective instruction literature. A second tool is Scenario Builder, which is a software system for preparing and presenting case-based problem solving scenarios. Development in this area is based on the emerging literature on the use of cases in teacher education. A third tool is based on the literature concerning the use of concept mapping. Map Maker is a software program for creating maps illustrating the connections between the key course concepts. Finally, the fourth tool involves the creation, storage, and retrieval of knowledge bases. The development in this area is supported by the literature on the increasing importance of information processing skills.

The second component of *Teaching Assistant* involves Tools for Learning. These are full-featured products that professionals are expected to be able to use in their work. Examples include: word processing, database, spreadsheet, and telecommunications. It is also expected that faculty will want to incorporate a number of content area-specific tools. As a result, one important related activity involves extensive searches for commercially-available K-12 and higher education software. While it is impossible to imagine all the possible combinations of software that might be appropriate, *Teaching Assistant* will have the capability of launching any program. As a starting point, the literature provides an excellent basis from which to select programs that have been identified as being high-quality and having a significant installed base (Neill & Neill, 1993; White & Righi, 1991). The conceptual foundations which guide the development in this area are found in the work of Gustafson and Reeves (1990) who observe that new approaches to using technology for instruction will serve to blur the distinctions between education and training. Thus, professors will be able to introduce students to essential "tools of the trade" as well as model strategies that increase the effectiveness of these tools.

The third component of *Teaching Assistant* consists of Coursework Management tools. To this end, templates and strategies would be developed to assist faculty in creating a number of specific applications for their course, including: planning notes, syllabus, class calendar, strategies for success, gradebook, course assignment profiles, and a study guide maker. The conceptual foundations that support development in this area are based in the instructional improvement literature.

The fourth component of *Teaching Assistant* involves the use of technology as a repository of text, graphics, sound, and video that can be accessed individually through libraries or integrated into other tools on the desktop. This approach enables faculty members to build an electronic library in a manner and style of their own choosing (a critical attribute in the literature on personal information systems). In the context of teaching, a serendipitous event could prompt the professor to access an item within one of the libraries. This storage system also provides a convenient method for linking various items in the context of presentations: graphics, student work samples, quotes, etc..

Applications

The creation and use of a multimedia interface that serves to launch custom software, commercial software, and control peripherals like videodisc players represents a significant advance in technology integration efforts by: (a) filling a void in the commercial marketplace for a common software interface, (b) facilitating faculty training, (c) reducing the mechanical demands placed on the instructor during class time, (d) reducing the response cost (time and resources) to lesson preparation, and (e) creating a standard environment that can also be customized or expanded to meet the needs of any user.

The development, evaluation, and modification of a multimedia interface like *Teaching Assistant* represents an essential task for facilitating the process of technology integration in teacher education. Studying the design, implementation, and effectiveness of this type of tool facilitates understanding how technology enhances teaching and learning in college classrooms Currently, *Teaching Assistant* is being field-tested at universities in four states. Readers interested in additional information about this project or in serving as a field-test site are encouraged to contact the authors.

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Five Practical Examples of Software Integration in University Level Courses

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As the potential for computer use in higher education increases, the pressure to integrate computers in curricula also increases. With this pressure, the reluctance and excuses for non-implementation continue to mount. Some of the most common responses given when asked why computers are not being used are:

a.) it is difficult and impractical to integrate the computers into the curricula;
b.) it will take too much time;
c.) the students won't learn anything more from the computer than from normal instruction; and
d.) computers are all fun and games; learning is a serious matter.

Although these excuses may be valid in a few instances, for the most part they are founded in misconceptions about computer technology. To challenge the misconceptions and illustrate the utility of computers in higher education, especially teacher education, five specific instances of the implementation of computers in instruction have been developed in this article. The five instances briefly describe and detail the following:

a.) the various abilities of the software applications used,
b.) the time investments required of the instructors to learn the programs and develop instructional materials,
c.) the student prerequisites and time investments
d.) the links and complements between the computer programs and the regular curricula, and
e.) the potential learning outcomes and benefits of integrating computers and instruction.

Because of the recent interest and investigation of cognitive links, semantic networks, and knowledge structures, the five software packages selected for the following curricula integration examples require concept links and knowledge structures to be developed by the student. Each of the five integration examples centers around a different program. These programs include the authoring program *Authorware Professional®* , the presentation package *Action!®*, and the concept mapping and knowledge structure programs *Inspiration®* , *SemNet®* , and *Learning Tool®*. The following instances are examples of the implementation of computers in instruction and will hopefully challenge the misconceptions and illustrate the utility of computers in higher education, especially teacher education.

Authorware Professional®

Authorware Professional® is an authoring program that allows users to create their own programs and instruction on the computer without learning a computer language. It is a software tool that can easily incorporate multimedia such as sound, video, and graphics, and it is available on both Macintosh and DOS platforms. As an instructional tool, *Authorware Professional®* could be especially beneficial to preservice teachers as they experiment and discover alternative ways of teaching and learn the fundamentals of instructional design.

Authorware Professional® could readily be used by both the instructor and student in an undergraduate learning theories class with only the basic knowledge of how to operate the computer as a prerequisite for the students. The instructor must obtain a slight working knowledge of the program, but by no means must the instructor become a programmer or computer whiz. On the contrary, within three weeks of working with the program, adequate knowledge should be acquired. Within those three weeks the instructor should be able to create a small program that outlines the basic learning theories and their underlying principles. Associated with required readings for the course, this program would be used to replace overheads and could easily involve such multimedia aspects as graphics, video, and audio to address the needs of the various learning styles within the class.

The students, after completing the required course readings, could run the program to gain insight into various learning theories. Class discussions would also be included to alleviate any misconceptions or elaborate upon any unclear areas. Once the learning theories were presented in the course readings and on the computer, the students would then be required to make their own computer program involving content from their specific content area and designed around a specific learning theory. For example, an education major with an emphasis on biology may create a computer lesson on the classification of a species using the behavioral learning theory approach. Because the student will have already been introduced to *Authorware Professional®* in the beginning of the semester, it will only require approximately three to four class sessions to learn enough basics of the program to complete the assignment.

Upon completion of the course, the students will have created computer programs that belong to them, learned the application of various learning theories to content, learned the basics of an authoring program, created an alternative way of teaching, experienced an alternative way of teaching, brushed up on their content area, and hopefully developed an understanding of how computers can be used in education. *Authorware Professional®* allows the students to accomplish all of this while it also addresses the needs of various learning styles. Likewise, it allows for student interaction and promotes a cognitive process that does not normally occur in a plain lecture classroom.

Action!®

Action!® is a presentation package capable of incorporating text, graphics, motion, interactivity, and audio with minimal effort. In essence, it can produce highly sophisticated slide shows and presentations without requiring a great deal of computer knowledge from the user. Obviously this computer package would be ideal for anyone in higher education who creates presentations. However, this package could also be useful to preservice education majors who are learning about multimedia and computer applications. In a multimedia course it would be easy and practical to integrate the use of *Action!®* with the readings so that concepts are linked together and illustrated at the same time.

Because of the ease of the program, the prerequisites for the students would require only that they know the most basic steps of operating a computer. The instructor would be required to have a working knowledge of *Action!®*, but the program is easy to learn and this could be accomplished with minimum effort in only a few weeks.

To implement *Action!®*, various articles and readings on multimedia would be read and the instructor would perform a brief presentation on the articles using *Action!®* to illustrate what will be expected of the students. One day of instruction on the operation of the program would be given to provide students with enough knowledge to create their own brief presentations. For the next group of readings, the students would pair up and create short presentations incorporating the basics of the program and tying together the readings. As the readings covered materials such as graphics and audio in multimedia, brief instruction on the use of those features in *Action!®* would be provided and the students would be expected to incorporate those multimedia features into their presentations of those readings.

This process would continue and the outcomes would be that the students had practiced implementing all types of multimedia, tied related readings together, and became proficient in using a presentation package. The benefits of the instruction involve the interaction of the students with each other and with multimedia, the hands-on practicality, the cognitive processing that would be required to logically develop the presentation, and the presentations themselves which could be reviewed at any time for future reference.

Inspiration®

Inspiration® is a conceptual mapping program that allows the user to create the content and content links, and make detailed connections between various concepts. It is a simple cognitive tool that can be used in any college classroom to illustrate and review concept relatedness and the infrastructure of any type of content. The program is fairly simple to use and can be adequately learned by the students in two class sessions. The only prerequisite of students would be that they understand the most basic knowledge of using the computer. The instructor would need to acquire a good working knowledge of the program, which would take no more than one week.

In courses, required readings are often related. Because of this, *Inspiration®* is the perfect tool to allow students to integrate the readings and link the primary concepts together. To accomplish this, after instruction is given on *Inspiration®*, the instructor would require the students to build concept maps which link the main concepts of the readings together. No breadth or depth limit should be imposed. Rather, the student would be free to create as detailed a map as necessary to build the knowledge structure for themselves. Discussions of the readings and maps would occur during class to alleviate any misconceptions or redirect any misunderstandings of the materials.

By using *Inspiration®*, the students would be permitted to create their own knowledge structures in a format and pace that was most suitable for them. They would use cognitive processing to organize and relate concepts and they would gain a conceptual understanding of the interrelatedness of the materials. *Inspiration®* also allows student interactivity and permits the student to control their own learning.

SemNet®

SemNet® is another conceptual mapping program. It allows for extremely detailed and connected conceptual maps involving numerous levels, and could readily be used with preservice education majors. One of the primary functions of a teacher is to organize and deliver instruction of specified content. However, organizing this content is not always easy, and deciding on the order of presentation is another difficult task. This is an area in which *SemNet®* would be ideal. In an undergraduate class teaching content organization and lesson planning, *SemNet®* could be used to aid the student with these tasks.

The prerequisite skills for the students would require that they possess the basic knowledge of how to operate a computer. Because *SemNet®* is so versatile and in-depth, at least three class sessions would be required to teach the students how to use the program properly, and approximately two weeks would be required of the instructor to learn the program prior to the course. Once this was accomplished, each student would then be required to create a concept map of a lesson. Each of the primary concepts of the lesson must be included as well as all subconcepts that would be addressed. No breadth or depth restrictions or requirements should be placed on the maps to allow the learner freedom to develop as detailed a map as necessary to create an individualized knowledge structure for those concepts.

Once the concept map was complete, the student would use it for reference when developing lesson plans and to identify prerequisite skills that need to be taught first. Using *SemNet®* would permit the students to create their own knowledge structure of their content at a pace and format that was most productive to them. It would force them to recognize connections between concepts and allow them to conceptualize their content area in a global fashion. It would also require extensive review of the content area and allow students to recognize concept interrelatedness. *SemNet®* also provides student interactivity and promotes deep cognitive processing on the student's part.

Learning Tool®

Learning Tool® is a conceptual mapping program also. It allows users to create detailed concept maps and submaps, and provides the user with an electronic notebook that will store information on each of the various concepts. *Learning Tool®* is an easy-to-use study guide that has the capabilities to test the user on the concepts entered. This makes *Learning Tool®* the perfect candidate for use in an undergraduate study skills course.

Because *Learning Tool®* is easy to use, the only prerequisites of the student would be a basic knowledge of how to operate a computer. One class period would be sufficient to teach the students how to use *Learning Tool®* and they could use it for the rest of their college career. The instructor would be required to have a good working knowledge of the program which could be acquired in less than a week.

As part of an undergraduate study skills course, *Learning Tool®* could be taught and used throughout the course. The instructor would illustrate the uses and how to operate the program and then require the students to use *Learning Tool®* to create a concept map of content from another course that was causing them problems. No restrictions or requirements would be made on the depth or breadth of the maps. The student would be free to create as detailed a map as necessary to connect the concepts together and develop a knowledge structure of the content. Once the map was complete, the students would be required to use the testing feature included in Learning Tool® to review the concepts and links that they had developed. The students would be required to create at least four maps in a semester to promote cognitive processing and interactivity.

The use of *Learning Tool®* would permit the students to work with difficult concepts and create their own knowledge structures of these concepts. They would proceed at their own pace and in a format most suitable to them. Cognitive processing would be used to organize and relate concepts and a conceptual understanding of the interrelatedness of the content would be acquired. In essence *Learning Tool®* would promote student control of the learning process.

Conclusion

Five various applications of computer software in higher education classrooms have been elaborated upon. However, these examples are just the tip of the iceberg. The possibilities are endless and are just waiting to be discovered. The benefits of incorporating computers into the curriculum far outweigh the perceived inconvenience of integrating them. Educators need to recognize that if they are not utilizing the most beneficial and available resources in their classrooms, they are not only cheating themselves, but they are cheating every student that walks through their door.

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Curriculum-based Single Switch Applications

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Single switch technology can be used with cognitively able students who have severe communication disorders to evaluate and develop a variety of curriculum-based skills. The essence of single switch technology is using a specific intentional behavior (e.g., pressing a lever switch) as the basis for communication. For students who are cognitively able, single switch technology can be an important link for successfully participating in regular curriculum activities. The purpose of this paper is to describe the use of single switch technology within the context of the regular school curriculum.

A single switch task consists of a series of computer generated alternatives that are sequentially scanned (i.e., somehow highlighted) so that a student can register a response by selecting one of the scanned alternatives. The single switch device can be in the form of a lever controlled by a simple head movement, a tread switch activated by a foot or hand movement, or any device sensitive to an intentional movement (e.g., a puff of breath or very slight but intentional muscle movement). When the switch device is engaged while an alternative is scanned, that alternative is selected as the response.

Methods for highlighting alternatives include using alphanumeric characters, geometric shapes, encircling or underlining alternatives, or spatial orientation (e.g., temporarily indenting each scanned alternative). If the switch is not engaged while an alternative is scanned, the next alternative is automatically scanned. After all the alternatives have been scanned, the scanning process begins again with the first alternative. This process is repeated until a selection is made or until a specified number of scan sequences have been completed.

An important variable during the scanning process is the scan duration. If the scan duration is three seconds, each alternative is highlighted for three seconds before the next alternative is scanned. The most suitable scan duration depends on the motor ability of the student and the task content, and must be determined on an individual basis.

A single switch task requires one or more switch movements. For alternative array scanning, a task often consists of a stimulus or stem and array of two or more alternatives from which a selection is made. The stem might be a verbal statement that requires a student to select a correctly spelled word. For example, the teacher might say, *House. Find the word house.* The student then selects the word from among a series of alternatives via a single switch.

Single switch items can be presented in various multiple-choice formats. One example consists of a written stem and a series of four alternatives displayed horizontally. The item could be presented auditorily via a speech synthesizer, or in a larger point size for students with visual difficulties.

For cognitively able students who cannot communicate by means of traditional methods, single switch technology can be an essential tool for successfully accessing curriculum-based content. However, in order to use single switch technology effectively to develop receptive and expressive communication, several important factors must be considered regarding the intentionality of behavior, single switch task characteristics, and the integration of single switch technology with curriculum-based content.

Intentionality of Behavior

Assume that a student who had no previous academic experience (viz., the student has no reading skills) is given a single switch task involving matching the stimulus word CAT to the alternative ANIMAL. Given a single switch device, the student might engage the switch when the correct alternative is scanned. In this situation, a correct response does not signify intentional behavior; that is, engaging the switch while ANIMAL is scanned does not indicate that the student is able to make the verbal relationship between CAT and ANIMAL.

Because of the multiple-choice character of many single switch tasks, guessing and/or random behavior is often a confounding variable. When a student selects either a correct or incorrect alternative, the response might indicate unintentional or completely random behavior, uncertainty about two or more alternatives, or the fact that one of the distracters is very plausible.

Just as an incorrect single switch response can be intentional, a correct response can mistakenly suggest task and content comprehension. A common mistake made when using single switch technology is a failure to discern the meaningfulness of responses. A student who has no reading skills whatsoever still has a 25% probability of selecting a correct answer by chance given four alternatives. A curriculum based on random behavior is not only ineffective, but limits the use of educational activities and materials that are conceptually appropriate.

One method for minimizing chance responses for an array scanning task is to increase the number of alternatives. If a multiple-choice format is being used to record single switch responses, four or possibly five alternatives are probably adequate; fewer alternatives leaves much to chance, and more alternatives can make for a very difficult task and increased scan time. When questions are framed within a true/false of yes/no format, the solution to the problem of randomness is to ask more questions. In either case, the meaningfulness of single switch responses can only be determined by carefully analyzing a student's single switch response pattern.

In addition to evaluating actual single switch responses, the student's behavior while responding will often provide insights as to the meaningfulness of responses. If a student hits the keyboard repetitively and/or continuously, a selection will be made but the intentionality and meaningfulness of that "selection" will be highly suspect.

When working with a student during a single switch task, care must be taken not to provide the correct answer. This might be as unintentional as a change of inflection or intonation during a single switch task, or as blatant as cueing the student by saying, "Select the correct answer," when the correct answer is scanned. Of course, providing cues when first introducing a new task or content might be very appropriate in order to ensure task comprehension. However, every single switch task should be designed to develop independent behavior. The goal of single switch technology is to provide legitimate learning experiences, and not to create a fiction of learning by responding on behalf of the student.

Task Comprehension

Determining a student's ability to comprehend curriculum content is essential for developing a viable curriculum-based single switch program. Single switch technology does not obviate the need for student-teacher interaction, but should provide increased opportunities for assessing the student's ability to comprehend.

There are several ways in which single switch technology can be used to engage the student in curriculum activities and to assess content comprehension. As already discussed, a very forthright method is to provide a stimulus or item stem, followed by a series of possible alternatives. Although this type of stem-specific format can provide important assessment information, displaying a question and a series of alternatives specifically relating to the stem restricts the use of the alternatives with other item stems. The following item illustrates the limited communication utility of stem-specific alternatives:

Which amendment states that the right to vote will not be denied on the basis of sex?

Sixteenth

Seventeenth

Eighteenth

—> Nineteenth

Instead of using a stem-specific format, the stimulus could be in the form of a question, followed by a list of generic alternatives so that the student responds either YES or NO following an item stem:

Teacher: "Does the Nineteenth amendment state that the right to vote will not be denied on the basis of sex?"

—> YES

NO

A variation of the above format would be to ask the question, and then list four possible choices on the board or notepad:

Teacher: "Which amendment states that the right to vote will not be denied on the basis of sex?"

1) 16 2) 17 3) 18 4) 19

—> 1)

...

By using a speech synthesizer, the selection of alternative 4 results in the synthesized answer: "The answer is number 4."

Yet another possibility would be to use a limited language board comprised of eight possibilities that could be used in a single switch format to respond to a variety of statements and questions:

```
            TRUE

            FALSE

            YES

            NO

   —>       MAYBE

            PLEASE REPEAT

            1

            2

            3

            4
```

Open-ended Array Scanning

Open-ended array scanning requires that the student actually construct a response thereby reducing to a great extent the problem of guessing and random behavior. Consider the array of possible choices below where the alternative RET (RETURN) indicates that a complete answer has been entered. For the item 2+2, the student first selects 4 and then RET to signify that the answer has been selected. For the problem 7+16, 2 is first selected, then 3, and then RET:

```
RET 0    1    2    3    4    5
    6    7    8    9

>23
```

There are many variations of this type of task, and methods for expanding the number of alternatives to correct entries and to synthesize answers. Instead of using numbers, the elements could contain alphabetic characters. The student is asked to spell the word CAT using the array of letters.

Matrix Scanning

Although more difficult than array scanning, matrix scanning is used to provide virtually unlimited forms of expressive communication and to minimize problems associated with guessing and random behavior. Instead of displaying an array of alternatives, the alternatives or elements from which a selection is made are displayed in matrix form. The size of the matrix can range from a simple 2x2 matrix, to matrices with 100 elements or more elements.

```
        YES       NO      CORRECT   INCORRECT STOP

   —>   1         2       3         4         5

        A         B       C         D         E

        REPEAT    ?       MAYBE     NEXT      LAST

        EXPLAIN   YES     NO        REA
WRITE

   >
```

For a matrix single switch scanning task there are several ways to scan and select matrix elements. The simplest method is to scan each element from left to right and from top to bottom. The matrix elements are scanned sequentially until an element is selected. This is suitable for smaller matrices but can be very time consuming for a larger matrix. Thus, for a 5 by 5 matrix containing 25 elements, where each element is scanned for approximately two seconds, the student would need to wait approximately 50 seconds before the last matrix element is scanned.

Instead of scanning items sequentially, row/column scanning can be used first to select a row, and then to select a specific element from that row. Matrix scanning is frequently used with nonverbal elements as a basic communication board. A communication board element might contain a picture of a TV, another a person drinking from a glass, and a third a radio. When the element illustrating the TV is selected, a synthesized message such as "I want to watch TV" is presented. Even though matrix elements can be reduced to relatively simple nonverbal forms (i.e., a drawing of milk cartoon replaces the printed word MILK), the matrix scanning task, especially when row/column scanning is used, can be difficult to conceptualize.

Open-ended Matrix Scanning

If a student is cognitively able, open-ended matrix scanning provides unlimited forms of expressive communication. Because this type of scanning task requires two distinct switch responses for each selection, matrix scanning is conceptually more difficult than array scanning. Before introducing a student to matrix scanning, the student should be familiar with various types of alternative array scanning tasks.; and before introducing open-ended matrix scanning (viz., writing), the student should have developed an underlying base of reading skills.

An open-ended scanning task with a letter matrix provides the most versatile form of single switch communication in that a response can range from a single letter to very complex messages. To make a selection from a letter matrix, the rows are first scanned until the row containing the letter is found.

The row scan can be in the form of a pointer or cursor, or each row scanned could be highlighted in inverse mode, underlined, or displayed in a different font or point size.

When the switch is first engaged for an open-ended matrix scanning task, a row of elements is selected. The elements of the row are then scanned until the switch is engaged a second time and the specific row element is selected. To facilitate matrix scanning selection speed, matrix elements could be arranged on the basis of probability of occurrence.

In addition to using a single switch for written communication, a speech synthesizer can be used to vocalize individual letters, words, sentences, or entire sections of text. The elements of the matrix can consist of letters, numbers, or a combination of characters and processing commands. The last row of the matrix shown below contains several processing commands for performing such tasks as synthesizing, beginning a new communication, filing, and printing communications. The size and complexity of the matrix can be expanded to include additional columns or rows to change elements to lowercase and vice versa, or to add additional keyboard characters and processing commands.

	A	B	C	D	E	F	G
	H	I	J	K	L	M	N
—>	O	P	Q	R	S	T	U
	V	W	X	Y	Z	.	?
	!	TALK	NEW	FILE	PRT	MENU	<—
	>YES						

Single Switch Task Variations

Depending upon such variables as muscle control and cognitive ability, single switch communication can be used in a time-based framework. A Morse code format is used by equating a dot with a switch response of less than one second (i.e., the switch is engaged and then released in less than one second), and a dash with a switch response greater than one second. A sequence of Morse code dots and dashes is thereby used to produce the letter R by first engaging the switch for less than one second, then for more than 1 second, and then for less than one second. The R corresponding to the .-. sequence is then displayed and synthesized. To present a word or message via a speech synthesizer, a special sequence of dots and dashes is used (e.g., .-.-.-).

In addition to traditional scanning and time-based responses, there are a variety of other techniques that can be used to record single switch behavior. An inverse switch format requires the user to engage the switch to initiate the scanning. The switch is engaged until the desired alternative is highlighted. When the switch is disengaged, the alternative being scanned at that moment is selected.

Time-based single switch tasks such as Morse code can facilitate expressive communication, but these tasks do require a fairly high degree of motor control. For a student having difficulty engaging and/or disengaging a switch, a time-based single switch task can be extremely difficult.

Single Switch Variables

Every single switch task must be individualized to meet the specific receptive and expressive communication needs of the student. As was previously discussed, scan speed is an important variable and should be closely scrutinized to ensure that the most appropriate scan speed is being used. If visual acuity is a factor, font and point size must be considered.

Many single switch programs provide access to variables which control factors relating to the number of alternatives, sound capabilities, and different types of feedback available. In some cases, a variable setting might require certain hardware enhancements such as a specific type of speech synthesizer. Feedback is extremely important when working with students using single switch technology, but should accommodate the student's ability and learning needs.

The Single Switch Curriculum

By far the greatest deficiency of programs for students with communication difficulties but who are cognitively able is depriving them of regular curriculum experiences. In order to remedy this, cognitively able students using single switch technology should be provided with as many regular curriculum activities as possible. This is not to be achieved by "dumping" a student using single switch technology in a regular classroom, but can only be achieved by providing support to adapt and modify materials and software, and to ensure that the student is following a reasonable learning progression.

The regular classroom teacher need not become an expert in single switch technology, or devote an inordinate amount of time to a student, to assist students using single switch technology to participate successfully in the curriculum. For a classroom teacher simply to acknowledge the fact that a cognitively able student with a severe communication disorder can profit from regular classroom experiences can be a vital step in developing a viable learning program. There is no secret special education curriculum that is invoked to teach science, mathematics, social studies, etc. If a student is capable of understanding and partaking in the regular classroom curriculum, the regular classroom teacher has the experience and expertise to present that curriculum best.

In addition to providing much needed curriculum expertise, the regular classroom teacher can do much to encourage meaningful communication. As a teacher becomes acquainted with single switch technology, the possibility of promoting receptive and expressive communication within the classroom is greatly increased. This might mean nothing more than asking a question that can be answered using a single switch device.

Providing a student with a variety of normal curriculum opportunities, in addition to those accessible via single switch technology, is invaluable. If a student is able to digest regular curriculum content, then the student should be exposed to as many regular curriculum activities as possible.

The student's responses in such situations may be limited, but this does not mean that such an immersion in the curriculum is not essential.

What sometimes happens when working with a student who has a severe communication disorder is a tendency to reduce the number of communication experiences, especially after several unsuccessful communication attempts. A student with a severe communication disorder does not need fewer communication experiences, but more...providing the experiences result in meaningful communication. If a student appears not to comprehend a single switch task, the task should somehow be modified, clarified, or simplified. Ignoring a student's apparent inability to understand, or avoiding language experiences which might indicate that lack of comprehension, will completely muddle attempts to develop a coherent curriculum-based program. Again, the goal is not to pretend that learning is taking place, but to monitor student progress consistently and to make program modifications when necessary.

Technology is available for individualizing the curriculum to meet the needs of students not able to use traditional modes of communication. For students with severe communication disorders, portable communication devices, screen readers, hardware to individualize commercial software, and a variety of augmentative communication devices and techniques are available to facilitate learning. However, one factor that excludes some students from the regular curriculum is not a lack of technology but using that technology to access the regular curriculum. By providing adequate support to modify and individualize the curriculum, and to integrate technology and curriculum, much can be done to meet the learning needs of students with severe communication disorders.

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Implementing Information Systems in Colleges of Education: Narrowing the Gap Between Theory and Practice

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In Kentucky, colleges and universities are required under the Kentucky Education Reform Act of 1990, to have in place by 1996 performance-based, outcomes-oriented teacher education programs. This mandate reflects a movement in public policy away from the assessment of educational programs by "inputs" (curricular offerings, faculty credentials, etc.) and towards "outcomes" (the success of students on specified criteria). In addition, the state government has shown a desire to simplify teacher certification rules, to promote alternative certification programs, and to establish statewide teacher assessment centers (Governor's Task Force on Teacher Education, 1993). To meet the requirements of performance-based, outcomes-oriented teacher preparation programs in Kentucky, to compete with alternative route professional development programs, and to maximize available program resources, it will be increasingly necessary for Colleges of Education to invest in Information Systems. Unfortunately, most colleges of education are in a poor position to implement sophisticated information systems. Not only do they tend to lack the necessary hardware infrastructures, but they also have limited experience with information management.

Murray State University's College of Education has a long history of activity with information systems, beginning in 1983 with the purchase of the first Apple II to promote the "computerization" of program support. Over the succeeding ten years, experience has suggested that a new way of conceptualizing systems development is necessary to meet the information systems needs of teacher education programs.

Difficulties Facing Colleges of Education in Developing Information Systems

Colleges of Education (COEs), especially those based in mid-sized state universities like Murray State University typically find themselves on their own in their efforts to expand information technology resources. The centralized university computer system staff is typically sympathetic to the information needs of the college of education, but often unable or unwilling to invest the necessary time and resources in the information systems needs of the COE. This is because the information system needs of the college of education are different from those of other colleges. COEs are required to conform to stringent state certification standards, to operate extensive field and clinical programs, and to account for the professional skills of all graduates.

As COEs embark on the expansion of their information systems, the problem of adequately estimating costs looms as a major factor in planning and budgeting. Not only is there a limited concept of what an information system entails, but additionally, in many cases funds are derived from year-by-year savings, windfalls, or special allocations, resulting in college planners having little opportunity to engage in formal long-range planning for information system expenditures. To minimize these handicaps COEs must begin to overcome their lack of sophistication about information systems and to alter their ideas about systematic planning.

Towards a More Adequate Concept of Information Systems

To plan effectively for growth in information systems (IS) requires a clearer understanding of the nature of information systems. Historically, the functions associated with information have been grouped in organizational structures with different names. A 1983 survey of 344 large organizations indicated that different names for information services included: *Management Information Systems, Information Services, Information Systems, Data Processing*, and *Information Resource Management*. (Cresap, McCormick and Paget, 1983). Banks and Williams (1987), in their review of information systems in education, suggested that naming should follow the function of the organization. They identified "Instructional Information Systems" as the name for the systems operating in school districts which are charged with organizing and manipulating student data to support instructional planning. Davis and Olson (1985) describe a Management Information System (MIS) thusly:

A Management Information System is:

- an integrated user-machine system
- for providing information
- to support the operations, management, analysis and decision making functions
- in an organization.

The system utilizes:

- computer hardware and software
- manual procedures
- models for analysis, planning, control, and decision making, and
- a database.

MIS, according to Scott and Perkins (1990), is a "hybrid" organization; both centralized and decentralized. They suggest that although MIS is typically a supporting staff department within most organizations, it also typically has definite independent responsibility for the operation of the computer/communications facility.

To summarize, within an organization, an information system is a specific sub-unit comprised of support personnel, computer and communication hardware and software, a centralized database of appropriate data, and policies, procedures, and materials to support organizational activities . For most COEs the concept of a stand-alone information system is at least unusual. However, given the need to redesign teacher education programs into more effective, outcomes-oriented entities, the imperative to develop more formally organized information system units becomes more palatable when comprehensive planning strategies are understood and utilized.

Toward A More Adequate Concept of Planning

Koory & Medley (1987) have listed ten advantages for systematic planning. Of the ten advantages, the four which seem most important for COEs are:

1) planning encourages achievement (the act of evolving the plan and writing it down often provides the impetus for achievement),
2) control is facilitated,
3) plans can be the basis for identification and evaluation of alternatives, and
4) a plan tends to force managers to visualize and understand the overall situation.

Typically, college of education personnel would have no difficulty with the concept of comprehensive planning. However, planning in the past has not resulted in an interest in information systems. To make the connection between planning and IS, the concept of planning must be elaborated.

Koory & Medley (1987) have developed a representation of levels of planning which has application for Colleges of Education (COEs).

Levels of Planning

Strategic	Tactical	Operational
Conceptual	Developmental	Execution
Corporate Level	Divisional Level	Departmental Level
General Direction	Specific Product	Task Oriented
Long Term	Intermediate	Short Term
2 to 5 years	18 months or less	Immediate

This conception of planning is useful because it forces decision makers to think about the differences between day-to-day activities, immediate long range goals, and the fundamental missions of the college. Davis and Olson (1985) provide another way of looking at levels of planning with their concept of levels of use of Management Information Systems (MIS).

Levels of Involvement with Management Information Systems (MIS)

Highest Level: MIS for strategic and policy planning and decision making
Higher Middle Level: MIS for tactical planning and decision making
Lower Middle Level: MIS for operational planning, decision making and control
Lowest Level: Transaction processing, inquiry response (Davis and Olson, pp. 6-7)

Information systems, once implemented serve the college depending on the level of use. At the lowest level, the information system is used to automate tasks which were being done manually, albeit quicker, and in a more capable and convenient fashion. At the lower middle level, information is provided for program management and it permits immediate future operational planning. At the two higher levels, the information system facilitates actual long range planning; first at the 1-2 year level, and then at the strategic, or long-range level. Use of IS at the highest levels, however, is frustrated when there is not accompanying COE program planning at the higher levels of planning.

Levels of use of the IS system are undoubtedly tied to the concept of planning in the college. For example, strategic planning is more likely to focus on the COE program as a whole, with an accompanying search for resources to accomplish goals... of which IS is an important component. At the highest level of planning, focusing on IS as one resource among many tends to bring out the relationship between resources, highlighting the possibilities enabled by IS, rather than allowing IS to be an end in itself. On the other hand, focusing planning at the lowest level, the operational level, has the opposite effect. It encourages the compartmentalization of IS to complete activities and achieve recurring ends. As COEs learn to exercise all three levels of planning in concert, all four levels of use of information systems resources also become more evident.

The Experience of Murray State University's College of Education in Establishing An Information System

Since the purchase of its first Apple II, the College of Education at Murray State University has dramatically increased the amount and diversity of technology dedicated to promote the optimal use of information for the benefit of the teacher preparation program. Centered in the Teacher Education Services (TES) unit, the college has established and upgraded a Novell local area network (LAN), purchased computers for all TES staff, almost completed the process of placing a computer on each professor's desk, and established a relational database of student and class information. Further, considerable effort has been expended in utilizing the accumulated information system to manage the admissions, certification, and field experience programs of the college.

The MSU College of Education is located in three different buildings. The initial IS-oriented LAN was installed in the primary administrative building, and during the past year LANs have been established in the other two buildings. Plans for the future include the establishment of a college-wide internetwork to extend IS services throughout the college.

The MSU College of Education Experience and The Concept of Information Systems

Using the Information Systems concept developed earlier, some differences between the concept and the MSU experience are evident. First, at Murray State University there has not been a separate administrative unit devoted to Information Systems. Rather, Information Systems existed as a functional sub-unit of a more traditional teacher education services unit. Second, there has not been a professional Information Systems staff. The staff assigned part time IS duties were trained in other areas and learned IS functions on a self-taught basis. Third, there has not been a regular budget assigned to information services. Funds have been generated on a project-by-project basis, often at the end of the year. However, over the years, an expectation of support for Information Systems has developed, and the college has made extraordinary efforts to provide funds. Fourth, activities of Information Services have been primarily focused on the activities of the teacher education services unit, rather than being integrated into all aspects of the COE program, including recruitment, instruction, university relations, etc. Fifth, manual procedures and models for analysis, planning, control, and decision making have been internally oriented to the aspects of the teacher education program within the purview of teacher education services. It has not been necessary to develop materials and procedures for more general college-wide use.

The MSU College of Education Experience and The Concept of Planning

During the years in which the MSU college of education Information System has been developing, the system has been used primarily at Davis and Olson's (1985) first two levels of MIS use; transaction processing, and management information for operational planning, decision making and control. Relatively speaking, IS has made possible many activities, with fewer personnel resources, than was previously the case. In fact, during the past five years the teacher education program at Murray State University, and in Kentucky in general, has grown dramatically, and the growth of the information system has made it possible to process the additional workload with little addition of personnel. Those instances in which Information Services-related staff have participated in Koory and Medley's (1987) Strategic and Tactical levels of planning within the college have usually been in relation to planning for the expansion of Information Systems itself. Major goals for IS, established early on, centered on the establishment and maintenance of a central database, on the establishment and support of an IS-oriented Local Area Network, and on the systematization of teacher education services-related activities. These strategic goals remained constant to guide tactical planning and were reviewed regularly as decisions were required about allocating resources to annual IS projects.

Abstracting from the MSU College of Education Experience Toward A Revised Concept of Information Systems

Murray State University is a progressive regional service institution with an excellent record of success in its College of Education programs. The College of Education has devoted considerable resources to its Information System, and is generally pleased with the results. As has been shown, the MSU COE Information System lacks a number of formal characteristics of IS, and the system is not participating regularly in the college's strategic and tactical planning. A common approach to making improvements, would be to propose bringing the college IS more into line with the traditional IS concept. This would entail proposing the establishment of a new operating unit and an increase in either budget or personnel, both of which are highly unlikely to produce results. Therefore, it may be more fruitful to suggest revisions of the IS concept to be more in line with COE realities. Four areas for revision are developed below.

IS in the context of a College of Education is likely to be a more decentralized, less independently-organized unit. The IS staff will primarily be service-oriented, with responsibilities to carry out program-related tasks, in addition to IS functions. Although it is desirable that there be a professional IS staff, that is not likely to be the case. The IS staff will in all likelihood need extensive training and support in order to be able to supply the same training and support to others in the college.

IS in the context of a College of Education will probably have inadequate and irregular budgets, making predictable budget planning difficult. Budgets for hardware/software maintenance and support will also be inadequate. However, service and support can often be negotiated through the university, through other departments in the college, and from other IS personnel in the institution.

IS in the context of a College of Education should be expected to take on the management of many mission-critical functions. The establishment of a central database, IS-oriented LANs, and standardized management and accounting procedures are central to the concept of IS and within reach of the COE Information System. Although these functions may be at the lower levels of a levels-of-use hierarchy, they can and should be of great value to the college.

IS in the context of a College of Education should be expected to adhere to many of the characteristics of formal IS units. Systematic procedures, careful development and maintenance of a database, care and development of the hardware/software infrastructure, and development of models for analysis, planning, control, and decision making should be expected of any college information system. For this to occur, careful attention must be paid to opportunities for IS staff to seek professional development. IS publications, opportunities to attend IS meetings, and formal training when needed will all be important. Although the idea of a formal information system may be foreign to many COE decision makers, for IS to have a greater impact, the language and concepts associated with IS can and should be used to the greatest extent possible.

IS in the context of a College of Education should be used more for Strategic and Tactical planning than is currently the case. Mission statements and Strategic Plans are not uncommon in universities and colleges. These existing documents can be used as a starting point in considering how existing goals and plans can be assisted by information systems.

Suggestions for College of Education Information Systems, Given a Revised Concept of IS

Information Systems in Colleges of Education can be expected to exist with fewer resources than more formally organized and budgeted stand alone IS units. However, even though this is the case, the resources expended by the college for Information Services will be considerable. As a result, for IS to achieve the greatest amount of impact, the IS staff will need to think creatively about ways to maximize benefits while minimizing costs. Constantly reviewing the concept of IS within the COE environment is one step. Reducing complexity and the need for outside support is another. For example:

1. IS should focus on widely available technologies and software. Because there is often a limited budget for maintenance and support, only the most reliable, proven technologies should be chosen for purchase.
2. Focus on a balance between new acquisitions and upgrades. Because the COE Information System is always underfunded, there is a natural tendency to expand facilities, rather than to upgrade existing ones. To ensure continuity and stability, the entire IS infrastructure must be tended.
3. Collaborative funding of technical support with other units within a university should be encouraged. The COE at Murray State University cooperatively funds a computer technician with other units in the university.
4. Purchase of part-time development expertise to overcome on-site expertise gaps. Students and retired IS professionals, among others, can be given personal service contracts to complete aspects of a project which are beyond the expertise of the IS staff.

Summary

This is a time of increased pressures on Colleges of Education to reform their programs, increase efficiency and effectiveness without increasing costs, and to compete successfully with alternative professional development programs. Information Systems have been shown to provide a competitive edge for businesses with similar pressures, and these systems can also be of great value to colleges of education. However, the standard concept of Information Systems must be adapted for the unique circumstances of these colleges in order for them to be understood and encouraged. To achieve the full potential of Information Systems, colleges must engage in more high level planning. It is in high level planning and decision making where IS can provide a competetive edge. Finally, because in Colleges of Education IS will most likely operate with quite limited resources, IS staff members will need to think creatively information management, and constantly seek ways to extend their own IS knowledge and expertise.

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Creating Your Own CD-ROM: An Overview

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For most of teacher education's history the most common form of "instructional support" has been a printed handout. Over the past 90 years the way those handouts were produced has changed regularly as newer technology became available to educators. The text-only handout provided by a teacher educator in a normal school in 1904, for example, might have been written out by hand on a stencil and duplicated on a gelatin hectograph or "ditto" machine. Today a similar handout might be desktop published on a Macintosh Quadra and mass produced at a Kinko's Copy Center.

Although the desktop published handout might include graphics and text formatting, the very nature of printed materials prevents the teacher educator from including materials such as video clips, databases, electronic presentations, HyperCard and LinkWay programs, or audio messages. Traditional instructional support materials, even those that are desktop published, cannot include such materials even when they would be very useful to students. There is, however, an emerging group of electronic tools such as Adobe Premier, Passport Producer, and many others that were created to make it possible and feasible to produce a wide range of materials that include video, sound, and animation. In the future teacher educators may well provide their students with "handouts" that include a range of multimedia materials. That possibility leads us directly to the topic of this paper– a means of delivering multimedia materials to students (and other teacher educators) that is efficient and inexpensive. One delivery medium is the CD-ROM.

The cost of producing 500 copies of a CD-ROM are quite low - as little as $2.00 per CD. However, the cost of creating the first disc, from which others will be mastered, has been as high as $2,000. And, if you want to create "one of" CDs at your institution the cost of the equipment required was high. Until recently, the cost of producing your own CD-ROM was extremely expensive compared to cost of other methods of electronic storage. A few years ago, Recordable CD or CD-R desktop systems were in the $20,000 price range for a very basic unit. This is quite a bit out of the budgets of most instructional technology departments. Today, desktop CD-R systems can be purchased for as little as $4,000.

CD-R Systems

A number of companies, including Sony, JVC, Kodak, and Phillips have CD-R systems that are within the price range of many Colleges of Education. Pinnacle produces a CD-R system, for example, that retails for under $4,000. It is available in versions for MS-DOS systems or Macintosh. At the other end of the price spectrum JVC's Personal RomMaker system sells for around $15,000 with all the available options. As you might expect, the price of the system is, at least to some extent, associated with quality, ease of use, and features. A CD-R system can, with some oversimplification, be divided into three components: hardware, storage, and software. CD-R systems can be purchased as bundled packages that include all three components (e.g., the JVC Personal RomMaker or the

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Pinnacle system) or as individual or unbundled components. If you were interested in creating a dictionary or telephone number database, for example, several companies sell CD-R software that automates the task of creating the database and retrieving the resulting information from the database when it is on the CD-ROM.

Hardware

All CD-R systems have a CD drive that reads and writes CDs. Blank CD's can be purchased for between $20 and $35 from several suppliers. CDs are available in two capacities (680 megabytes and 540 megabytes). Once you produce a CD on a CD-R it can be read by CD drives on ordinary computers. The drives in the CD-R systems vary primarily in terms of their speed. A double speed unit, in a system like the JVC Personal RomMaker, will produce a CD twice as fast as a single speed drive such as the one available in the Pinnacle system.

Storage

The obvious reason for storing material on a CD-ROM instead of a diskette is capacity. Today a high density floppy disk stores 1.44 megabyates of data and costs around 75 cents. A CD can store 680 megabytes and, if produced in quantite, can cost as little as $1.00. If you have over 15 megabytes of material to be distributed, a CD is a very cost effective way of doing it. The high capacity of the CD leads to another problem, however. If you are going to put 680 meg of data on a CD you must have some way of storing that much data in the computer. CD-R systems deal with this problem in a number of ways. The Pinnacle system passes the problem on to you. To create a 680 meg CD you must have that much storage capacity in the disk drives of your computer. JVC, in contrast, comes with a large hard disk drive built in. Using the software that comes with the JVC equipment, you can identify files on any disk drive connected to your computer (or the network your computer is attached to). Once those files are identified, the JVC system brings all of them over to its hard disk drive. You can then produce the CD from the files on the dedicated JVC drive.

Another option available on some systems is a digital audio tape (DAT) system. DAT cartridge drives are commonly used to back up large hard disk drives, and, until recently, many of the companies that duplicate CDs for distribution preferred, or required, that the data you wanted on the CD be supplied on a DAT tape. Most now accept a CD you have produced on a CD-R system in place of a DAT cartridge. However, a DAT drive in a CD-R system is still useful if you will be making many CDs because it allows you to save the image of a CD, including all the files, to a cartridge. Then you can erase the drive and load files for another CD.

Software

On the hardware side, the size and range of storage capacity (hard drives, DAT drives) varies significantly from one system to another. On the software side, there are wide differences in the capability, ease of use, and versatility of the software that controls the CD-R hardware. For the novice there is much to be said for buying a bundled system that includes everything: hardware, storage, and software. If you purchase coponents and put them together yourself there is always the change of getting the dreaded twin diseases of "It is hardware's fault," says the software supplier and "It is softrware's fault," says the hardware supplier. Even in bundled systems, however, there is great variability in the software supplied with the system. Some systems provide software that requires considerable programming expertise to use effectively. Others, such as JVC, supply software that is simple, straightforward, and "point and click." Ease of use is a crucial factor to consider when evaluating the software, but features can also be critical. For example, the standard software that comes with the JVC Personal RomMaker can create CDs in a variety of formats. It cannot, however, create CDs that include audio tracks that can be played on standard music CD players. The optional software to do that costs an extra $1800. Other options that may or may not be included in CD-R software packages include the ability to produce multisession CDs (that is, add files to a CD that already has files on it) and the ability to produce CDs in the Kodak PhotoCD format.

Most of the features to consider when evaluating CD-R software, and hardware, fall into two categories: disc formatting standards and file structure standards. These standards are discussed in the following sections.

Disc Formatting Standards

There are a number of basic formatting standards for producing CDs that are in widespread use. Each of the standards listed below prescribe how the information is laid out or formatted on the CD. This section will describe the functionality and the benefits and drawbacks in using each standard.

Red Book

The Red Book standard is the basis for all the other CD standards in existence today. Introduced by Sony and Philips in 1980, the Red Book or Compact Disc Digital Audio (CD-DA) standard is the format used to create the millions of CDs found in record stores across the world. All music CD players can play this type of CD. All computer CD-ROM players on the market can play a CD-DA, but only if the software drivers for the CD player support this feature. The Red Book standard includes a way for the player to identify and correct defects that can occur on the CD that commonly can occur.

Yellow Book

The Yellow Book standard was also introduced by Sony and Philips. They realized the CD could also be used for high capacity storage in the computer industry by making a small change in the definition of the Red Book standard's data area. The Yellow Book standard is commonly called the Compact Disc - Read Only Memory (CD-ROM) standard. The Yellow Book standard is divided into two groups, Mode 1 (computer data) and Mode 2 (compressed audio data and video/picture data). Mode 1 includes three levels of error correction that helps data integrity. Most CD-ROMs in use today on computers are CD-ROM Mode

1. CD-ROM Mode 2 only has 2 levels of error correction. Mode 2 CD-ROMs are extremely rare, but can be read by most CD-ROM drives made for computer use if you have special software.

Mixed Mode

The Mixed Mode standard combines both the Red Book standard for audio and the Yellow Book standard for computer data. Normally, the computer data is written into the first track on the CD while the audio tracks are stored in the remaining tracks (up to 98 more). With the growing use of multimedia in education and entertainment, mixed mode CDs have become much more popular. The reason is the way sound is processed on Yellow Book CDs versus Mixed Mode CDs. Sound on a Yellow Book CD is just another data file. The computer must load the sound file, process it, and then play it through the sound card in the computer. That puts considerable load on the computer and can slow a program down. On a Mixed Mode CD the computer program in the first track can include data on when the player should play an audio track or a segment of an audio track. The sound produced comes from the audio-out connection on the CD player rather than from the computer's sound card. The result is often much higher quality audio and faster program execution.. Mixed Mode thus allows the multimedia author to load their program into the computer's memory while using the CD player as an audio player. Software such as Macromedia's *Authorware Professional* and *Macromind Director* can incorporate these audio tracks into presentations and programs. Mixed Mode CDs can be played on an audio CD player, but there is one precaution. If you try to play the data track, track 1, the result is very loud static that can damage speakers and ear drums.

CD-ROM/XA Mode 2

The CD-ROM/XA Mode 2 standard was developed by Philips, Sony, and Microsoft. CD-ROM/XA Mode 2 is an extension to the Yellow Book standard that includes computer data, compressed audio data, and video/picture data. In Yellow Book Mode 2, only compressed audio data and video/picture data are allowed in a track on the CD-ROM. CD-ROM/XA Mode 2 interleaves the computer data with the compressed audio in each track. This is accomplished by a 8 byte sub-header in each sector. The sub-header determines whether the information contained in the sector is Form 1 (computer data) or Form 2 (compressed audio data and video/picture data). By interleaving both compressed audio and computer data into the same track, it appears that on playback that the two run concurrently. The advantage of CD-ROM/XA is that the compressed audio and computer data run at the same time, whereas the Mixed Mode CD will have to load one of the two before running the other. There are, however, two big disadvantages to CD-ROM/XA. The first is the cost of the hardware to make and access the information and the second is the quality of the audio. The compressed audio on a CD-ROM/XA track is limited to 4 bit samples at a 37.8KHz sampling rate. The Red Book standard allows for a higher quality 16-bit sample at a sampling rate of 44.1 MHz.

Green Book (CD-I)

The Green Book standard is identical to the CD-ROM/XA Mode 2 format except it includes a specific operating system called CD-RTOS. This operating system allows a CD-I disc, such as the Philips CD-I, to run on a unit connected directly to a TV. It is a specialized standard used when creating CDs to run in CD-Internactive players which sold primarily to the home market.

File Structure Standards

Since the developers of the disc formatting standards failed to specify a file structure to use, CD-ROM makers were forced to create their own. Below is a summary of the most common file structure standards in use today.

High Sierra

The *High Sierra* file structure was created by a group of industry representatives in a Nevada hotel. The reason for creating this standard was to allow software manufacturers to rely on a common set of CD-ROM drivers that, when installed on a computer, would ensure that their CD could be read by the computer. The High Sierra standard was submitted to the International Standards Organization in 1986. After a few years of deliberation, the International Standards Organization published the *ISO 9660* file structure standard. It is an extension of, and a modification of, the High Sierra structure.

ISO 9660

The ISO 9660 standard is compatible with most Apple Macintosh, MS-DOS, and Unix-based microcomputers. Today it is the standard format for CDs that will be read by both IBM and Macintosh compatible computers. The ISO 9660 standard primarily specifies what characters are allowed in naming files and directories, how long the file name can be, and how the directory structure is organized.

The directory structure of an ISO 9660 is hierarchical in structure with the first level or "root" containing the Volume Descriptor. The CD can have up to eight different levels. The ISO 9660 standard also specifies that the path to a file on the disc not exceed 255 characters. ISO 9660 also restricts the characters allowed in the file structure so that Unix, Macintosh, and MS-DOS computers can all read the file and directory names and limits file names to 30 characters.

Due to the fact that MS-DOS computers can only read filenames no longer than 12 characters, ISO 9660 was divided into 3 "levels of interchange". Level 1 is standard in the MS-DOS world because it specifies that each file have: a single file section (contiguous), a file name that contains no more than eight characters, a file name extension that contains no more than three characters. In addtion, the directory cannot contain more than eight characters. Note that the naming convention for ISO 9660 Level 1 Interchange is more restrictive than the MS-DOS file naming convention.

ISO 9660 Level 2 Interchange specifies that only the file have one file section. Level 2 discs commonly are found in the Macintosh and Unix platforms since both allow longer file names than ISO 9660 Level 1. Level 3 Interchange is a "pure" ISO 9660 format. There is no requirement that a file have only one section. A file could, for example, have a section that includes program code and another that has audio data. Level 3 discs are commonly found on CD-ROM/XA and CD-I (Green Book) systems since they both support compressed audio and data files in the same sector.

HFS, MS-DOS, and Hypird Structures

CD-ROMs can also use the Macintosh HFS or the MS-DOS file structure. Macintosh HFS discs can only be used on a Macintosh system. The advantage to the Macintosh HFS for Macintosh applications is that this standard allows "long" Macintosh-style file names and regular Macintosh icons for files. Apple Computers has written extensions to their operating system which allows ISO 9660 discs (Level 1 or Level 2 Interchange), High Sierra, and HFS. HFS is the only standard which will allow Macintosh file "characteristics" to appear as a Macintosh user would expect. The other two formats allow only the basic Macintosh icons to appear (application, document, and folder). Microsoft has also written extensions which will allow a MS-DOS system to read ISO 9660 (Level 1 Interchange), High Sierra, and MS-DOS discs.

A "hybrid" disc contains one or more different file structure formats that can only be accessed by a computer that is able to read that particular format. For example, a "hybrid" disc could be created that has files in the Macintosh HFS, ISO 9660 Level 1 Interchange, and MS-DOS file structures. The information on the disc that conforms to the Macintosh HFS structure could only be read by the Macintosh, the information conforming to the MS-DOS structure could only be read by a MS-DOS computer, and the information in the ISO 9660 structure could be read by both Macintosh and MS-DOS computers.

Creating a CD-ROM

The creation of a CD-ROM can be compared to the creation of a book. This section briefly describes the steps necessary to create a CD-ROM. and an actual CD-ROM that was created at the University of Houston (Table 1). The College of Education's Instructi has been working on a Teacher Education CD-ROM that includes MS-DOS and Macintosh files. The example in this section was created on the JVC Personal RomMaker, Macintosh version.

Content

The first step in creating a CD-ROM is to make a conceptual decision on the topic. Using the "Book" analogy, this is similar to deciding on what topic the author will write about. The author asks themselves questions about who is the intended audience, what information should they receive, and is this topic feasible. Once the topic of the proposed CD-ROM has been decided, the next step is to create or find the information that will be included.

Defining the Directory Structure

Once the content has been developed or obtained the next step is to decide on a disk and file stucture format for the CD. Custom file and folder icons might also be developed for Macintosh (HFS) CDs. If the CD-ROM will only be used by Macintosh computers, the disc format of choice might be Macintosh HFS since it contains the file "characteristics" of a Macintosh desktop. However, if the information to be presented is text files or graphics in formats such as GIF, TIF, or PCX that can be read by diferent types of computers, the CD-ROM could be Yellow Book-ISO 9660 Level 1 Interchange so that MS-DOS, Unix, and Macintosh users can access the information.

Make and Test a Virtual CD-ROM and/Or a "One of" CD-ROM

Some CD-R systems allow you to create a virtual CD-ROM on a hard drive that will "behave" as if it were a CD. That allows you to verify correct operation of the CD and to test for potential problems such as faulty files, slow operation, and program bugs. The virtual CD feature was more important when developers had to send the files to a CD plant to produce even one CD. Today, when a CD can be produced on a CD-R system in less than 30 minutes for less than $35, many developers skip the virtual CD stage and make a single CD. Then they test that CD thoroughly and make changes as needed to the image on the CD stored on the hard drive. Then they make another CD and test it. When they have thoroughly debugged the CD it is ready to be replicated.

Replicate the Pre-Mastered CD-ROM

If only a few copies of a CD are needed, it may be cheaper to make them one at a time on your personal CD-R system. If, however, you need several hundred, or several thousand, it will be much less expensive to send a copy of the CD you have tested to a replication plant. The cost of replicating CDs in quantity depends on a number of factors including quantity, packaging, and label type. To illustrate the process, assume you need 1000 copies of a CD, that you want the label (the top of the CD) to be printed in one or two colors, and that you need the CD to come in a simple plastic slip case (as opposed to the "jewel box" most music CDs come in). Printing the label in two colors is normally supplied as part of the base price for replicating. Thus, if you supply the artwork to be used for the CD label, there would be no extra cost for that. (PageMaker 5.0 has a template for creating a CD label.) The simple plastic slip case may also be standard. At most it should not cost more than 5 cents. (Jewel boxes may cost as much as 35 cents each in quantities of a 1,000.) The price for our example CD might thus come down to the cost of creating the CD master (typically $700 to $1,200 for a small quantity CD, free if you are creating 10,000) and the per unit cost. A reasonable price might be $700 for the master and $1.20 per CD. It is possible to find lower prices, however. In the summer of 1993, for example, one replicator offered a *summer special*: 1,000 CDs for a total cost of $1,500 including jewel boxes. If you supply a manual with the CD that must be inserted into the case, the cost of printing and inserting the manual is in addition to replication.

Two companies that replicate CDs from one of CDs produced on CD-R systems are: Disk Manufacturing Company (800 433-DISC) and Athana International (800 421-1591 in the USA and 44 753 511070 in the UK). Disc

Manufacturing produces several booklets on CD development and replication including *An Overview to Multimedia CD-ROM Production*, *Compact Disc Terminology*, *Integrating Mixed-mode CD-ROM*, and *Introduction to ISO 9660*. Some of the technical information in this paper was obtained from these brochures.

Conclusion

There are many uses for locally produced CDs in teacher education. Until recently the cost of producing CDs was prohibitive, but with the arrival of CD-R systems, it becomes an viable option for many projects that involve the creation and distribution of multimedia materials. In the not too distant future graduates might even provide electronic portfolios to prospective employers on CD. Such a portfolio might include video clips of the graduate teaching classes as well as audio of supervisors and instructors who comment on his or her proficiencies.

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Building Faculty: Reflective Decision-Making and Developing a Faculty Kiosk

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The School of Education at the University of South Dakota adopted Reflective Decision Making as its philosophy. Recently, a unit within the school, the Center for Interactive Technology for Education and the Corporation (InTEC), undertook the design and development of a faculty kiosk. Its purpose was to familiarize prospective students and visitors to the School with the faculty. The kiosk is a computer-supported data base about the faculty and programs of the school. An important feature of the kiosk is that it combines several kinds of data—visual, audio, and textual—for each faculty member.

This paper will outline the structure of the kiosk, the development of which required the faculty to participate. The character of this participation was remarkable because it mirrored the school's philosophy and the spirit of reflective decision-making. As the components of the kiosk are described, the faculty participation that was indicative of reflective decision-making will also be discussed.

Use of the term, reflective decision-making, is limited to certain fields; as a concept it is universal. The principle of reflective decision-making is that one thinks before acting in seeking solutions. The result is that one's actions are preceded by referring to whatever knowledge base is available. This is a rather liberating process in that, while there is the expectation that a person needs to think before doing, there is also the acknowledgment that one is capable of thinking, thereby acting in a responsible manner.

The Structure of the Kiosk

The reason for the development of the stack was to allow for the display of visual, audio, and text data about the faculty in a concise, speedy, private, and informative but non-intrusive manner. The format (design) of the kiosk follows the HyperCard® concept of a data base as a stack of cards. Considering that there are four divisions in the School of Education, the kiosk stack was divided into four main parts—one for each division. Navigation through the stack is made possible via buttons—one clicks a mouse pointer on a screen image to access data.

The kiosk displays introductory information: a title screen, a credits screen, and a main menu (or directory) which lists the divisions. On the latter screen, there is a button which accesses information about the stack. There is also a text search button allowing for specific searches of the textual data base by typing in specific terms rather than by clicking the buttons to move through the stack structure. This search function is available throughout the stack.

Access to faculty data is first available via the menu of divisions. Once a division is selected, a card is displayed listing the names of the faculty. One either clicks on the "next screen" arrow to "page" through the alphabetical arrangement of faculty cards or one clicks the person's name button on the division card.

Once a faculty card is invoked, the person's 32-bit digitized color image is displayed along with a navigation box (that is repeated throughout the stack) and four buttons for accessing displays of other data. The buttons are entitled "My Research," "Courses I Teach," "Did You Know?" and "Hear Me." The first three display text on a field which appears alongside the color image and disappears when another button for text data is clicked or when the card is closed. The "Hear Me" button accesses a recording on which the person's voice can be heard; it is a self-introduction.

In an effort to make the stack more interesting, attractive, and easy to use, color was added to the stack. Color is not a feature of HyperCard but it was enabled to display color using a colorizing external command (XCMD). This feature was especially useful since it allowed the assignment of distinguishing screen colors for each division within the School.

Faculty Reflective Participation

The design and programming of the kiosk was done by the InTEC group; collecting the data required the participation of all the faculty. Their participation was remarkable because it demonstrated a depth of reflection characteristic of the philosophy of the School of Education for teaching and learning. Whether it was the particular media used or the nature of the data that caused the faculty to demonstrate so clearly the principle of reflective decision-making cannot be completely ascertained, but their response was exciting because it suggests that media development may initiate reflective decision-making.

Specifically, three forms of data were collected for each person. Textual data were gathered using response sheets which provided an example of each type of information requested along with a blank section which faculty completed. Faculty were given the option of accompanying one of the developers in entering the text information in order to monitor wording so that it was to their satisfaction. Most faculty opted for the "live" text-entry interview. The capture of images and audio was accomplished using a video camera. Backup 35mm photographs which could be scanned into the stack were taken in case the video footage was unusable or lost. This was an unused but important precaution that would have saved time if needed because the logistics of having a faculty of approximately 100 members processed would certainly result in production delays if there were no backup for data.

There were several minutes of video shot for each person. The target was to have a single still image of each person per card. However, each person was videotaped for a few minutes so as to have the opportunity to select from several facial expressions and to allow the person to generate personal reflections that would be appropriate for the textual data.

The video footage was digitized in two steps. One computer program was used to capture and convert the video from analog format to digital and store it on a hard disk drive, another was used to touch-up images. InTEC members found that for some footage, the quality of the digitization improved if a video editor program was used on the footage digitized with the screen capture program. The audio portion of the video tape was captured and edited using the Audio Palette feature in HyperCard.

The videotaping of the faculty for the project was the means by which the faculty was provided an opportunity for reflective decision-making. The video clips of faculty demonstrate their engagement in the revealing, thoughtful process for which they prepared. It was this very preparation that so clearly demonstrated the reflective decision making process that the School of Education has embraced as its philosophy and which it models to its students.

Whether it was the medium, the content, or the task that caused the faculty to behave in a manner that reflective decision making would predict has not been determined. InTEC faculty are convinced, though, that the characteristics of the medium influenced them. Being videotaped requires participation and motivation—no one wants to submit to self-ridicule. It would be expected that most people would want to perform well in an activity that "puts them on the spot." This is what the effect of the taping and the interviewing was—it drew the reflective decision-making process out of the faculty. The result of the process was that the faculty revealed themselves, expressed beliefs about topics that they were not typically concerned with, and participated in the project—they learned about themselves and the topic. This was accomplished by using media and guiding its development with reflective decision-making. This process may have possibilities with other learning.

Videotaping is already used in the instruction of psychomotor activities such as sports and recreation, activities such as preparing food, administering inoculations to oneself, and job skills training. A person is more likely to prepare for being videotaped than if he or she were not. The taping activity includes several educational functions: informative feedback, opportunities for multiple feedback, self-modeling to practice, and the opportunity to explain oneself or demonstrate one's skill to the video camera. This last point of self-explanation is currently enjoying research support as a valid means for determining a person's skill and understanding while simultaneously encouraging their development. The development of the faculty kiosk helped our faculty to demonstrate reflective decision-making while simultaneously developing media about reflective decision-making. This process should enjoy successful application in other areas of instruction. It is the intention of the InTEC faculty to pursue the development of educational media as a means for instructing reflective decision-making.

Technical Specifications

The program, HyperCard (version 2.1), was used in the development of the kiosk. Colorizing HyperCard, developed by BungDabba was the external command that allows HyperCard to display color. The video capture software used was Screenplay ® by Super Mac, the image touch-up software used was Photoshop®, the video editing software used was Premiere®, both by Adobe.

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PRESERVICE TEACHER EDUCATION

Section Editors:
Andria Troutman
James A. White
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As one might suppose from its title, the papers in this section deal primarily with issues related to the programmatic integration of technology into preservice teacher education. This year's collection reflects five main areas of interest. As in previous years, a number of papers describe *comprehensive approaches* to planning entire programs of study and upgrading the skills of teacher education faculty. Also as in previous years there are papers that deal with *specific issues* related to instructional technology: evaluation issues, Logo, multimedia, one-computer applications, and special education applications, among others.

Five papers are included this year on less common, but no less important, topics. One discusses *facilities development* for colleges of education. The inclusion of two papers on *distance learning* reflects the growing interest in this domain. Finally, two papers remind us of the continuing value of other, *non-computing technologies:* videotape and two-way television.

Comprehensive Approaches

Andris, Nelson, and Smith describe LEARNINGS, the curriculum developing at Southern Illinois University at Edwardsville for integrating technology throughout the teacher education program in a variety of classroom and clinical settings.

Erb and Golden provide a narrative on Marietta College's ambitious program to integrate technology into undergraduate and graduate teacher education programs, in order to provide leadership to the surrounding school districts that they serve.

Faison describes Rowan College's response to the challenge of integrating technology into a 30-hour teacher education program.

Freeouf and Flank describe the outcomes of a project for training college faculty at the Westchester Education Coalition in the integration of technology into their teaching, also providing guidelines and implications for others who wish to implement similar efforts.

Specific Issues

Dell provides "how-tos" on integrating technology into the special education program at Trenton State College. Her message is applicable beyond the special education milieu.

Dickey, of Eastern Kentucky University, focusses on the selection and design of appropriate technological experiences using a wide array of multimedia, shareware, and other software for early elementary preservice teachers to enhance their effectiveness in implementing a wide variety of classroom management tasks.

Diem, of the University of Texas at San Antonio, provides samples of computer-related social studies activities for grades K-12 and encourages social studies teachers to explore different computer utilities when planning classroom experiences.

Ernest and Roy describe a collaborative project between the University of Montevallo and an elementary school in Shelby County, Alabama that not only provides Logo instruction to 5th graders, but also supplies a valuable clinical experience for prospective teachers. A review of

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some related research literature on Logo and some sample instructional materials are included.

Leavell, Peterson, Hall, and Caverly describe an experience using a portable computer with LCD panel to implement a database activity with teachers enrolled in Developmental reading classes at Southwest Texas State University.

Pan, of the University of Wisconsin at Whitewater, discusses the value of preparing teachers to adapt and to customize existing technology hardware and software resources in schools.

Waxman and Padron, of the University of Houstonpropose evaluation models useful for developing systematic tools that can lead to meaningful determinations regarding the effectiveness of technology-enriched teacher education and professional development programs currently in place, before such programs are replicated.

Facilities Development

Kortecamp and Croninger provide a thorough chronicle of research and planning that transpires from the initial stages of building a computer facility at the University of New England to the realization, staffing, and teaching in the real facility. They provide many suggestions for interested readers.

Distance Learning

Valmont, of the University of Arizona, provides a treatise on how to put together a distance learning facility and offers insights to training personnel for using such a facility.

Morgan describes, from a student's point of view, the experience of taking a college course via distance learning at Southwest Texas State University.

Non-Computing Technologies

McDevitt discusses early results of practical research ongoing at the University of Massachussetts, Lowell, in using two-way television technology to mediate an early field experience model.

Brent, Wheatly, and Thomson describe the use of videotape technology at East Carolina University to implement undergraduate microteaching experiences. Purposes are to build confidence, enhance reflection, develop specific teaching and peer assessment skills, and introduce assessment instrumentation.

The papers in this year's collection continue to evidence a trend away from infatuation with technology for technology's sake and toward the informed application of these powerful tools to meet educational needs, priorities, and agendas. Readers who are engaged in similar endeavors will find validation, support, and valuable information here. Readers who are *not* engaged in similar endeavors may become persuaded that they should be.

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LEAPINGS into the Future: Using Instructional Design to Develop an Integrated Preservice Teacher Education Computer Curriculum

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Since 1987 the School of Education at Southern Illinois University at Edwardsville (SIUE) has been involved in building an undergraduate teacher education curriculum integrating computer-related technology. The original impetus for this move was the funding of several grants which helped to build a state-of-the-art computer laboratory. These grants included an internal grant for a Macintosh based desktop publishing lab in 1989 and an IBM grant in 1990 for an ICLAS network and curricular integration. This program was first described in *Computers in the Schools* (Nelson, Andris & Keefe, 1991) and has evolved considerably since then. While our initial efforts met with modest success, two problems remained unsolved: the parts of the computer curriculum were not unified, and some instructors had still not assumed full-responsibility for their share of the integration. This paper addresses our current efforts to move forward toward our goal.

Excellent similar programs exist at other institutions. For example, one at the University of Iowa (Thompson, Schmidt, & Topp, 1993) may have accomplished more than ours during its 10 year existence when measured by faculty involvement and actual contact instructional hours. Still, the SIUE program's current focus on unifying the curriculum and insuring that faculty and student participation in the program continues to increase may be of interest.

Creating Unity and Involvement

The Coordinator of the program was struck by the phrase "leaping into the future" in early fall of 1992 as an inspiring description of the program. Later, with the addition of the letter 's', **LEAPINGS** became an acronym for the content components of the curriculum — eight areas of knowledge and skills useful to professional educators: Local area networks; Electronic mail and wide area networks; Artificial intelligence, expert systems and robotics; desktop Publishing and graphics; Integrated software, iNteractive video, CD-ROM and hypermedia; Grade and test management (teacher utilities); and Specialized subject-matter specific software applications: tutorial, drill and practice, simulation, and learning environments.

These eight curricular areas are grouped further into four general areas which form central themes in the program: Communications, Applications, Simulations, and Extensions. These four central themes are used to build a **CASE** for proficiency in the use of computer technology.

The original strategy was for the Coordinator of Computer Resources to design and/or develop modules of instruction in these eight areas for inclusion into the ongoing undergraduate teacher education curriculum at four crucial points: the first professional course, the general methods course, the specialized methods courses and the student teaching experience. All course instructors were to be involved in the development and formative evaluation of the modules. The connection between the modules and other course content was to be made explicit. Two general sessions, two hours long, regarding the first three points were offered. In fact, much progress was made following this model during the academic year of 1992-93.

As word of the LEAPINGS curriculum spread, graduate students in the instructional design program began to take as their final project the design/development of a module, working under the guidance of the Coordinator and with the instructors to produce and test the methods and materials in the courses of the undergraduate teacher education curriculum. Unity of design is assured by the Coordinator's working closely with these students. Modules can be of three types: individualized modules for bringing individuals to entry level competence, group instructional modules for common in-class experience, and project packets that help to reinforce knowledge and skills gained in the group instructional modules.

An additional program aspect which fosters continuity is that the supporting print materials for all modules are to be of uniform design. As lesson plans and computer assisted instruction for each module are designed and tested, the print materials are organized into chapters on the eight areas of LEAPINGS. Different portions of a chapter may be received at different points in the program. The result is that the students and faculty have a growing notebook on integrating computers into the curriculum, and the instructors have an additional teachers' manual outlining the program's purpose and curriculum. The chapter on electronic publishing and graphics is currently being designed, and will represent an example of document graphic and instructional design.

Faculty involvement is continually encouraged. The Coordinator meets with many of the instructors each semester to select, customize and redesign the modules to be used. Many new ideas and units of instruction have emerged from these interchanges. The Coordinator also continues to find ways to draw faculty into the electronic community through both group and individual training in the use of e-mail, conferencing, and list servers. In addition, the other two authors of this paper continue to share their computer expertise with faculty on a day-to-day basis, and are themselves involved in several research and teaching projects featuring computer applications.

The CASE for Integration

In the next four sections of this paper, details are presented of how the LEAPINGS curriculum is integrated into the undergraduate teacher education program.

Communication

A part of the strategy for creating unity and insuring full participation by the faculty has been the building of an electronic community which stresses communication. The Coordinator had studied the efforts of Bull and Harris (1992) at the University of Virginia, and modified these ideas for use in this program. The School of Education already had both a Novell and a LocalTalk network. A internal grant proposal was written through Academic Computing which funded the purchase of a NetWay 2000 gateway. Through this gateway, School of Education teacher education faculty had their offices connected to the SIUE mainframe. Now faculty have access to electronic mail, conferencing, and will shortly have full Internet connectivity. Training for all faculty is in process, especially for those teaching several central courses.

After much negotiation with the campus Office of Information Technology, preservice students now receive electronic mail addresses which they may keep throughout the program. They are taught and encouraged to communicate with their professors, and learn how to conference and join list servers during the program. For example, electronic communication is introduced in the Introduction to Education course. One professor helps to coordinate student work groups by assigning a group correspondent for each work group. This correspondent is responsible for reporting group progress and difficulties on a regular bases to the professor through e-mail. Another professor has set up an electronic conference with a number of important course topics, such as what makes a good teacher. Students are responsible for participating in this electronic discussion.

Faculty are currently being trained to use Bitnet and Internet lists that are related to their fields of expertise. Next year, subject matter courses, the students will work in groups to begin to tap these valuable on-line resources during their specialized . They will be taught responsible on-line behavior in a community of experts, and encouraged to critically use resources, such as the daily lesson plans, available through e-mail from CNN news.

We are also hopeful in the near future to introduce the newer hypertext and hypermedia-based Internet search capabilities to our students in some portion of the program. Current plans are underway to acquire our own Internet server and to install software that makes many of the Internet operations menu-driven.

Both faculty and students are trained in the effective use of Local Area Networks. The Novell network currently runs under IBM's Classroom LAN Administration System (ICLAS), and students in the Introduction to Education class learn to log onto the system using their own id and use the applications and educational software installed on the LAN. Handouts are available which orient the student to the advantages of both local area networks, and which describe the software that is available, more than 100 titles in the case of the IBM network. Faculty have begun to use the file-sharing capabilities of the LocalTalk network, and a token-ring campus area network will soon be available for those who wish to connect to it.

Application

The second aspect of building a **CASE** for proficiency in computer-related technology is applications. One of the complexities of a modern university environment is the diversity of entry level skills, including computer skills, that students in the same class have. Nowhere is this more apparent than in the area of applications software. Abilities range from no experience with a word processor to power spreadsheet and electronic publishing user, with all the shades of grey in the middle. We are designing a curriculum that will hopefully challenge most of the students.

The MicroSoft Works tutorial is easily available in our lab at 35 workstations. Using a check list, students in the introductory course assess what they do and do not know about word processing, data management, spreadsheets and charts. They then devote the rest of the time to familiarizing themselves with an unfamiliar aspect of integrated software. Another course requirement is that written assignments are to be turned into word processor, so that students are motivated to learn this aspect of computer competence. Incidentally, this curricular module was developed as a masters project under the guidance of two of the authors.

Our data show that while many students are receiving training in other programs in word processing and the use of spreadsheets, particularly WordPerfect and Lotus 123, most of them have little familiarity with integrated software and its relative economy and ease of use, especially for such tasks as mail merge, creating charts and or tables of numbers in a spreadsheet and pasting them into word processing documents. Modules are now being developed to allow students to pursue independently some project-oriented application for extra credit.

Students also are exposed to the desktop publishing environment in one of the two lab, with a special focus on using appropriate tools to produce effective teacher-made materials. In the general methods course, two modules are available, depending on the instructor's choice. Students can either produce a one page newsletter using Express Publisher in the IBM lab, or they can produce a teaching handout with graphics in the Macintosh lab using clip art and MicroSoft Works. These hands-on activities are supplemented by print materials.

In the specialized science methods courses, students learn to use both spreadsheets and data management tools to create science units. Two units have been taught in the past that demonstrate how applications tools can be used to teach inductive reasoning. One unit uses spreadsheets to chart and analyze weather over a two week period, and then uses weather charts and graphs to look at relationships between weather variables. The other constructs a database on Native American tribes and aspects of their culture, such as principal food, dwelling type, and so forth, to encourage analysis of the effects of various variables on culture.

Simulation

The third aspect of the **CASE** for proficiency in the use of computer technology is simulations. The aim of the program here is to build an appreciation of what is happening today in computer technology; everywhere one sees the attempt to accurately simulate and more than that, to extend human behavior, intelligence, perception, and experience. Into this category is grouped not only traditional computer simulations, such as the LocalTalk networked version of Oregon Trail, but also hypermedia, robotics, artificial intelligence, expert systems, and virtual culture.

The specialized methods courses — especially science, social science, and language arts — have been designated as a place where interactive video materials will be used as one nucleus for building effective lesson plans. Over the past year, a graduate student worked with the Coordinator and the instructors of these three methods classes to integrate interactive video into this aspect of the curriculum. For example, the social studies instructor has integrated the software package *Point of View* (an interactive videodisc-based hypermedia package encompassing historical events) into the methods class he teaches. He demonstrates how easily history lesson plans can be augmented with audiovisual material on such topics as "Martin Luther King's March to Selma" and "Kennedy and the Bay of Pigs." Students in these classes also may join Bitnet and Internet lists and engage in other forms of wide area networking relevant to the methods they are studying.

Another as yet undeveloped aspect of the simulations curriculum will be the study of artificial intelligence, expert systems and robotics as an extension of human capabilities and intelligence. This unit is targeted for the required educational psychology course. The planned activities for this course include the use of "outlining" or concept mapping tools such as **Inspiration** to illustrate various aspects of knowledge organization and representation in human memory. Another activity will involve the construction of a knowledge base (a set of rules for making decisions in a domain) to be used in an expert system. With these and other activities, teacher education students will gain insight into the nature of intelligence, the functions of human memory, and the learning process.

Extension

The final of the four aspects for the **CASE** for proficiency is the category of extensions. This idea embraces the two categories of teacher teaching content and teacher doing management-type activities. Some computer tools are *extensions* of the teacher in either the teaching mode or in the preparing for/managing teaching activities mode.

The same principles which govern the construction of good software, especially software with a strong tutorial component, are relevant to improving the teaching act itself. Teachers can learn about effective teaching from designing or evaluating tutorial software, and also, teachers can improve selection of software with a tutorial component by focusing on the adequate teaching act. Certainly, one important comparison to be made is the amount of interactivity and learner involvement necessary to an effective piece of computer assisted instructional software and the interactivity in a typical class where the student to teacher ratio is 30 to 1. Opportunities are provided throughout the program for viewing and evaluating a range of examples of software. Students are shown how to access available software in the introductory course. In the specialized methods courses, the focus is on using the software as a part of a well-designed course of instruction.

The second kind of teacher extension has been classified in the past as teacher utilities. In this program we focus on grade and test management, since they are such important aspects of the teacher's job that serve to support the direct teaching act. On the IBM LAN, we have both Excelsior Grade and Excelsior Quiz. Modules have been developed for both these programs for the general methods course. The most effective format we have found to present these (and several other) programs is to have small groups follow a series of questions designed to produce either a class grade file or a test document.

Not yet accomplished, but projected for the coming semester is a complete integration of the subject matter of student evaluation which is covered in the general methods course with the use of these two programs. Thus, the instructor of this course will work with the Coordinator to design Excelsior Grade and Quiz modules which will effectively use the evaluation concepts being covered in the students' textbook and in the lectures and other classroom experiences.

Other Program Aspects

Assessment and Redesign

The quality of the program is not currently being assessed with formal research design. The focus is on faculty and student interaction and exchange of ideas through virtual and real sessions, on periodic revision of modules and material based on observations and feedback gained through their use, and on the use of proven instructional design principles. We do use student evaluation forms in the initial phases of implementation of any curriculum module, and we take patterns of negative student comments seriously in the redesign of the materials.

We are also very much aware that making this curriculum is a little like building a ship while it is at sea. For example, it is very likely that next year's program will have significant revisions. The Introduction to Education has been cut to a 2 hour course, and therefore, more introductory material will have to be put into the general methods course. Additionally, next year will be the first year in which we attempt to triangulate between student teachers, cooperating teachers and university supervisors using e-mail and conferencing.

Continuing with the metaphor of building a ship at sea, the parts to the ship of educational computing keep arriving ever new, and can be somewhat incompatible with the parts now in place and successfully functioning. Actually, the continual upgrading of equipment and software can help to assure that the focus is on concepts rather than technology. Furthermore, in view of the diversity of installed bases of technology that our students are likely to encounter in the field and in their eventual positions, it is probably desirable to have several generations of software and hardware available for use and experimentation.

The undergraduate teacher education program is undergoing NCATE review this year. As part of this program, the Coordinator prepared a questionnaire on the integration of computer technology into the curriculum and distributed it to every active faculty member. The results of this survey and more in-depth follow-up interviews should help to further integrate and unify the curriculum and to avoid inappropriate sequences or levels of difficulty of content.

Related programs

In addition to this program, which is received by all undergraduate education majors in early childhood, elementary, secondary, and special education, the special education program continues to teach a three hour course devoted to the use of computer technology in special education which covers much the same content in relation to this discipline. In addition, a number of stand-alone courses, including courses in computer assisted instructional design; desktop publishing and instruction; computer networks and instruction; and computers across the curriculum, are available for senior students as well as inservice and masters level students.

Even though this brief paper outlines the core concepts and skills which we continue to integrate into our undergraduate curriculum, we are indeed fortunate to have several persons on our faculty who have made outstanding contributions to the field of computer applications in education. These faculty members all teach various courses which many of the students take. One person has developed the Illinois Rivers Project, an integration of science and language arts which makes use of an extensive FredNet-based bulletin-board system. Another is an internationally-known developer of problem-solving software. Still another has worked with the Region 16 Educational Service Center to integrate various aspects of microcomputer technology into mash kits which are available for area elementary science instructors. Other faculty are quite current in the computer applications in their field of expertise.

Conclusion

In conclusion, this paper has presented a synoptic overview of the LEAPINGS into the Future curriculum which integrates eight aspects of computer-related technology into the undergraduate teacher education program at SIUE. It has focused especially on how unity and faculty and student involvement have been encouraged, on the role of instructional design, and on the evolving nature of this curriculum. It is hoped that by sharing this information, the academic community can learn about yet another approach to this important topic.

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The Marietta College Model: Integration of Content, Methods, Materials, and Technology

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The Marietta College teacher education program supports a philosophy of holistic education, stressing the importance of the integrated curriculum for the education of the whole child. Elementary education methods classes typify this philosophy with the integration of language arts and social studies methods and science and math methods classes. At the secondary education level, methods classes encourage the integration of other relevant disciplines into the content of students' lessons. Included in this philosophy of curriculum integration is the understanding and use of technology across all content areas. Students learn how technology enhances classroom instruction and student learning. Through the integration of technology, teacher education students are able to appreciate its role as a vehicle for critical thinking and problem solving at all education levels and in all discipline areas.

Marietta College believes that, as a teacher education institution, one of our primary objectives is to serve as a technological leader for the public and private elementary and secondary schools in rural southeastern Ohio. Geographical isolation, size, and funding inadequacies have prohibited most districts in this area from effectively integrating technology into their schools. Through the Marietta College Model we are making progress enhancing the technological literacy of our students as well as the teachers and administrators of the surrounding school districts.

The Model in Action

All undergraduate education students at Marietta College are required to become technologically literate, knowledgeable, and skillful enough to integrate Macintosh computers, laser video, and CD-ROM technology into their teaching. This technological literacy is addressed in a variety of education courses.

Elementary education students enrolled in the Foundations of Reading course practice using CD-ROM technology through the creation of lessons which integrate software such as the Discus Books series and Broderbund's Living Books. During their field experiences in area schools many of these students take this technology out to classrooms with them as they implement practice lessons with groups of students. An entire literature unit has been built around Marc Brown's Arthur books. Using the Broderbund CD-ROM version of Arthur's Teacher Trouble as a stimulus, reader response and interdisciplinary extension activities have been designed to correlate with several of the books in this series. Students have been able to successfully field test this unit with second grade students.

In the Elementary Language Arts and Social Studies course, hypermedia is used by the instructor to present concepts in class and to model its use as a learning tool for elementary students. Hypermedia has provided a conceptually rich environment in which to integrate content and establish contexts for problem solving and critical thinking. After a hands on introduction to the process of authoring a stack with Roger Wagner's HyperStudio , students create their own literature response stacks to be used with elementary school children.

While many of the college students are at first hesitant to attempt this new technological feat, allowing students to work collaboratively on this project circumvents much of this anxiety. Two or three weeks into the project this cooperative arrangement pays off with even the most reluctant students when pieces of the process suddenly begin to click. These student-created stacks are built around works of children's literature and are intended to engage the elementary children in reading, writing, speaking, listening, and critical thinking activities. College students are encouraged to incorporate sound, scanned images, Quicktime movies, and laser video clips in their stacks. Students spend the weeks leading up to this experience previewing one another's stacks and offering constructive criticism.

A true test of the their stacks' worth comes when students are given the opportunity to work with children who spend a week on campus with their teacher during our visiting classroom program. Working in groups of two to three, the elementary children are able to sample a variety of the stacks during their week on campus. College students read the work of literature with the children to establish a context prior to introducing them to the stack. The children are then able to use the stack to respond to the story with their own text, graphics, and sounds.

Elementary and secondary students who are pursuing certification in the area of remedial reading use technology as a record-keeping tool during the college's summer reading clinic. Using HyperCard, students create a diagnostic record for each of the reading clinic participants, which includes pop up windows with formal and informal test results, a recording of the child's oral reading, a record of the college student's observations of the child, and a Quicktime movie clip of the child engaging in a literacy activity.

In the area of math and science, both elementary and secondary students are given experience with applying a variety of laser video discs to their classroom instruction. Students are trained in the use of the Jasper Woodbury series and given the opportunity to work with middle school students using the series in an after-school science and math enrichment program.

Secondary students learn to use laser video segments to demonstrate concepts, constructs, and problem solving scenarios. They begin by finding a scene from a laser video that demonstrates a concept. The scene is presented to classmates in a demonstration of their selected concept. This exercise not only provides experience with laser video technology, but also provides valuable experience in isolating the attributes and characteristics of their particular concept. The laser video segments provide rich visual contexts for concept exploration. Students find this experience to be memorable and significant in their ability to understand concepts.

One secondary methods requirement is to develop a complete two week unit plan. In addition to ten daily lessons, the plan must also contain a rationale, unit goals, a unit evaluation and a complete resource file. In an effort to integrate the use of technology into teaching, one of the daily lessons must include some form of computer, laser video, or other new technology. The entire unit is developed on disk, using a HyperStudio stack that the professor developed. Each student is issued a disk with a runtime version of the stack on it. The stack is designed to allow immediate access to all components of the unit plan through the use of buttons. The diagram in Figure 1 shows the

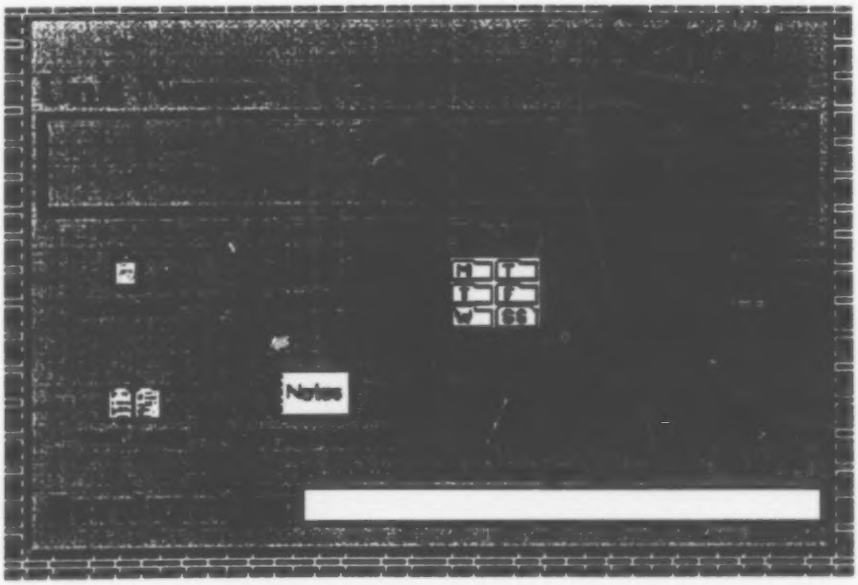

Figure 1. Navigation Icons

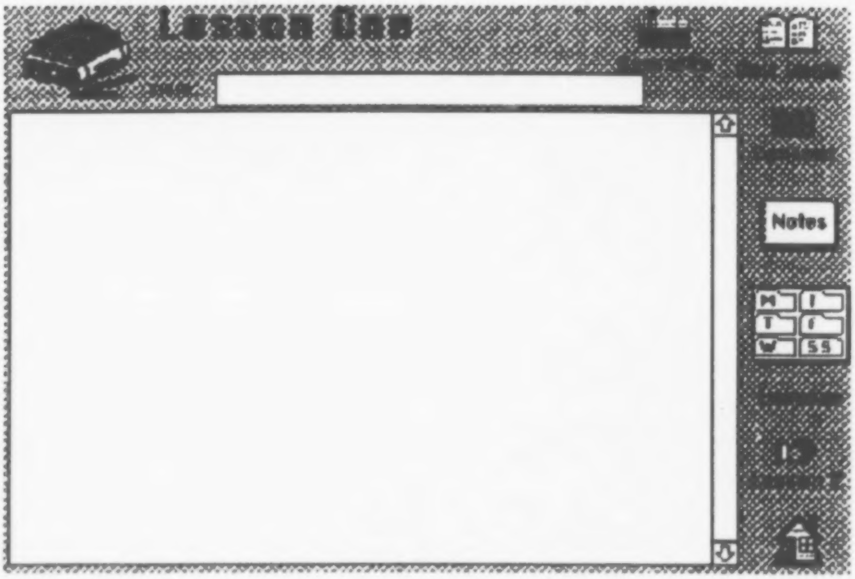

Figure 2. A Working Screen

button icons used to navigate to the various components.

Any of the unit plan components can be accessed from any card in the stack. For example, if a student is working on a daily lesson plan and wants to see the content outline, the student simply clicks on the content outline button and that screen immediately appears (see Figure 2). The instructor's comments and grades are in the "Remarks" section, which also can be accessed from any screen. Students can also add recorded messages and sound to their work.

Students in the methods class have commented positively about the HyperStudio unit plan. They enjoy the interactivity of the unit and feel that working on the computer is a beneficial part of their teacher preparation.

Marietta College believes that undergraduates who leave the college with teacher certification should be technologically literate and have the ability to incorporate technology into their teaching strategies. If students leave their undergraduate education without technological literacy, they will be less willing to seek this knowledge and expertise after they begin teaching. Marietta College wants its graduates to be enthusiastic about technology, seek it when they begin teaching, take a leadership role in procuring it, and advocate its use in the instructional process.

Changing Attitudes of Inservice Teachers and Administrators

Graduate students in the Master of Arts in Education program take an Advanced Instructional Strategies course as one of their core requirements. In this course students must develop a HyperCard or HyperStudio interactive stack that combines graphics, scanned pictures, laser video, and sound. Students work collaboratively on their stack development and present their stack to the class at the end of the semester. Their stacks are archived in the Curriculum Library and loaned to area teachers to be used in their classrooms. The graduate students are encouraged to integrate various disciplines into the content of their stacks, and each stack must have problem solving and critical thinking activities to directly involve students with the content.

One distinct difference between teaching undergraduate and graduate students to use technology is the reluctance of graduate students to interact with it. Generally, they are more insecure, hesitant, and negative about learning how to use technology to enhance their teaching. These students are veteran teachers, many of whom have not taken a college course for a number of years. Their prior experiences with technology are usually minimal and they fear the computer. The first six weeks are usually painful for both the graduate students and the instructor. The students feel that it is unfair to require them to learn to use the computer, to learn to use laser video, to learn to use software, and finally, to combine it all together into a sound interactive lesson. The most enjoyable moments of the semester are when these same students find a new self-confidence in their abilities to learn and become proud of their work. By the end of the semester, they are teaching each other, creating problem solving stacks, and cheering wildly when their fellow students present their projects. Some of these students go from threatening to quit the course and the program to buying a computer at the end of the semester.

These graduate students return to their schools with their new found enthusiasm for integrating technology into their teaching and demonstrate their abilities to their principals and fellow teachers. They become advocates for writing grants and securing funding to purchase technology for their schools. Most importantly, they encourage and introduce their students to technology and provide them with rich experiences.

Conclusion

The Marietta College model integrates technology into its teacher education program. The instructors in the Education Department model the use of the technology in their own teaching and require their students to demonstrate technological literacy and proficiency. The graduate students take a course in technology as part of their program core. These efforts have produced new and veteran professionals who advocate the integration of technology into their classrooms and consequently, teach their students about technology, affording them the opportunity to .learning.

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Integrating Technology into Teacher Education: A Modular Approach

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Electronic media and technologies of instruction have the potential to be an integral part of the teaching-learning environment at all levels. One way to increase the appropriate use of technology in our K-12 classrooms is through the education and training of preservice teachers. A 1990 survey of 282 colleges of teacher education conducted by the Center for Information and Communication Sciences at Ball State University found that teacher preparation institutions have a medium to high commitment to preparing their students to function in the information age, and almost all are implementing changes to make this goal a reality (Stowe, 1990). Another survey, conducted by the Center for Educational Research and Innovation (1992), concluded that the potential for improving teaching and learning will not be realized unless teachers are well-trained in the uses of new technologies.

Teachers must be competent in two areas. They must be able to operate technological hardware, and they must also develop competencies in identifying and using appropriate educational software and materials. Preservice teacher training has done more in the first area than the second. Despite providing instruction in the operation of hardware, inadequacies have been noted. For the most part, courses are short in duration, presented without connection to subject-matter, and void of integration of hardware with specific teaching styles (Center for Educational Research and Innovation, 1992). "It has become increasingly obvious that any expenditure for technology must be leveraged with a greater investment in teachers" (Jordan and Follman, 1993, p. 64).

According to the Association for Educational Communications and Technology (AECT), Guidelines for the Accreditation of Programs in Educational Communications and Information Technologies, teacher education programs should include research and instruction in the following areas: 1) systematic design of instruction to meet learner needs; 2) selection of media and interactive technologies; 3) preparation and production of media and technology; 4) utilization of media and interactive technologies; and 5) operation of media equipment (AECT, 1989). Teacher preparation programs must be dedicated to producing technologically literate teachers who will be able to function in the 21st century. In New Jersey, the Task Force for the State Technology Plan has identified several goals for preparing educators for new roles with regard to the use of technology. Among those goals are: 1) preservice teacher education programs must infuse appropriate applications of technology into professional sequence courses, and 2) educators at all levels must be prepared to use technology in classroom management to acquire detailed knowledge about student performance (Stapleton, 1992).

Constraints of New Jersey Certification Requirements

In 1986, the State of New Jersey changed its requirements for teacher certification, indicating that all elementary teacher candidates must have an academic major. Of course, this had already been the case for secondary teacher education candidates. The professional component of the program could not exceed 30 semester hours. In Rowan's case, 12 of these semester hours were designated for the full-time student teaching experience. In order to meet the 30 credit cap, many of the 'traditional' teacher education courses had to be revised, and subject-specific pedagogy courses were modified, streamlined, or eliminated. Isolated courses in educational media (the old 'audiovisual' courses) were among the first to go. With the increased demand for technologically literate teachers, and the decrease in time and credits available for professional courses, how could knowledge and use of technology be integrated into the undergraduate teacher education program?

Rowan's Modular Approach

As a result of the changes in certification requirements, Rowan (then Glassboro State College) revised its pedagogy courses in its undergraduate teacher preparation programs. Pedagogy courses in the elementary and secondary education departments incorporated a laboratory/field experience component. Using this laboratory component, technology modules were developed to be offered along with field experience opportunities. Reflecting the knowledge base for teacher education and research on the integration of technology in teacher education, this modular approach attempted to offer the skills, knowledge and competencies cited as important for classroom teachers. Other teacher preparation programs including special education, health and physical education, home economics and technology, quickly incorporated the use of these modules into their revised curriculum and methods courses.

Originally, three modules were offered. The first module concentrated on the research on the use of media in the classroom, examined attributes of various media formats, and introduced a method of systematic design. Module Two was a hands-on session that dealt specifically with equipment operation. The third module focused on production of instructional classroom materials. Each session lasted 1 1/2 hours and was presented by the instructional technology specialist. Any instructor teaching a pedagogy course could assign students to attend one to three of the technology module sessions.

While this modular approach was well-received, the need for modifications was noted. During the second semester that the modules were offered, departments designated specific modules that would be offered with specific courses, insuring that students would not be exposed to the same modules in more than one of their pedagogy courses. Also, a better system of recording and reporting attendance at sessions was developed. Sign-in sheets were made available for all regular course instructors. Students were held accountable for their attendance at sessions.

During the second year of implementation, two additional modules were added. One module dealt with an introduction to computers in education, and the second was an orientation to all print and nonprint media services available in the School. The modules were gaining popularity, but still the need for modification was noted. The major problem was that media instruction was still presented in isolated units apart from 'regular' classroom instruction, and the increased participation in module sessions was becoming more difficult to manage, since all sessions were still being presented by the instructional technology specialist.

In response, the modules continued to evolve and more coordination between the course instructor and technology specialist emerged. Media-use requirements became part of the field experience component of courses, coordinated grading of media projects by the instructional technology specialist and the course instructor began, and course instructors incorporated information from the modules into their assessment techniques.

Currently, six modules plus the orientation session are available to preservice teacher candidates. These sessions are as follows:

1) *Understanding Instructional Materials and Technologies* - roles and types of instructional materials are explored. Systematic instruction is introduced.
2) *Operating Basic Instructional Equipment* - students practice use of various media and technologies from audiocassette recorders to laserdiscs.
3) *Incorporating Instructional Materials and Technology in the Classroom* - based on assignments given by course instructors, students are instructed on the production of classroom materials.
4) *Word Processing* - a basic understanding of Clarisworks word processor is developed.
5) *Computer Managed Instruction* - demonstrations and hands-on experience with software used to support managerial tasks.
6) *Computer Assisted Instruction* - overview of existing and emerging computer technologies and their applications. (A second session may be scheduled to provide hands-on activities with selected software packages.)

Each session is 1 1/2 hours long. Sessions 1-3 are presented by the instructional technology specialist, and sessions 4-6 are now presented by the full-time computer coordinator. Faculty members scheduling the technology modules for their classes must meet with the two technology specialists to plan individualized content/grade level specific presentations. Faculty members are strongly encouraged to attend the technology sessions with their classes, and voluntary workshops on technology use are offered to faculty each semester.

Future Directions

The plan for greater integration of technology has become a college-wide focus at Rowan. There is a commitment on the part of the Office of Academic Computing to put a networked personal computer on the desk of each faculty member. This will facilitate movement toward a technologically literate faculty who model appropriate technology use. A new library is under construction which promises to offer state-of-the-art information technologies that can be accessed from faculty offices, computer labs, and student residential facilities.

Another campus-wide movement is the installation of 'smart classrooms' in each instructional building. The instructional technology specialists in the School of Education and Related Professional Studies (SERPS) have developed a proposal to facilitate the development and use of these 'smart' classrooms. This action plan, which has been titled T.E.A.C.H.E.R. (Technologically Enhanced Academic Classrooms for Higher Education at Rowan), will provide a variety of media formats which will be readily accessible to SERPS faculty for classroom use. The 'smart' classroom will be equipped with computer, video, and satellite capabilities, as well as the more traditional media formats such as slides, overheads, and large screen projection. Faculty will have the opportunity to creatively develop lessons which infuse a variety of electronic information into the traditional learning situation. This, too, will enable faculty to model appropriate technology use for preservice teachers.

It is hoped that with increased access to technology, and the appropriate support, teacher educators and teacher candidates will close the gap between the rapid advances of technology and the use of technology to support and enhance the educational environment. Rowan's modular approach is just one attempt to move closer to this goal. The outcome envisioned is a beginning teacher who is technologically literate and prepared to facilitate and improve the learning process.

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Preparing Teacher Educators to Integrate Technology into Required Courses: W.T.E.G.

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As part of a four-year effort to improve teacher preparation programs in Westchester County, New York, the Westchester Education Coalition has been spearheading a project with teacher education faculty in nine local colleges and universities. The project, known as the "Westchester Teacher Education Group" (WTEG) is aimed at giving new skills, knowledge, and understandings to teacher education faculty in four focus areas: technology, multicultural diversity, math/science, and work-based learning. This paper will highlight two years of activities and products with one of the four strands, the "WTEG Technology Task Force" and the emergent model used to support its work.

Participants

Beginning in November, 1991, the Westchester Education Coalition was awarded funding by the Wallace-Reader's Digest Westchester Fund to lead a two-year program to bring local teacher education faculty up to date in their knowledge and use of technology. Fifteen representatives from nine colleges participated in this effort, including: College of New Rochelle, Concordia College, Fordham University at Tarrytown, Iona College, Manhattanville College, Marymount College, Mercy College, Pace University, and Sarah Lawrence College. They were joined by nine classroom teacher-partners from local public schools in monthly training and support sessions provided by staff from the Iona Institute for Computer Studies. Periodic-curriculum integration sessions were facilitated by consultants from Bank Street College of Education. The Coalition planned and coordinated all activities. A grant from the IBM Corporation enabled the entire group to have PS/2 Model 55 computers and an advanced academic software package for use in their homes during the project.

Principles

One of the fundamental tenets of the WTEG project is that upgrading the skills and knowledge of teacher education faculty is pivotal to improving the preparation of teachers for classrooms of the present and the future. Another principle upon which the project operates is that changing teacher preparation programs must be accomplished through integration of new learnings as opposed to the traditional approach of adding new courses and new requirements. A third belief is that those who are learning new skills and trying to apply new knowledge must have their concerns addressed in multiple ways. To this end, the well-known CBAM, "concerns-based-adoption model" (Hall, et al, 1986) was used by the project's coordinator to work with participants and facilitators. In all, project facilitators recognized that successful change is contingent upon easy access, regular training, support, challenges, and opportunities to test and incorporate new skills and products in personally and contextually meaningful ways.

Training and Other Support

From January, 1992 to March 1993, the task force met at least once a month to receive training in DOS, file management, word processing, spreadsheets, multimedia, use of databases, e-mail, and telecommunications. Iona College's

"Institute for Computer Studies" provided the training, using a customized-for-educators version of a successful model used to train business personnel: six hour modules combining skills, information, and applications. To balance the work on skills acquisition, sessions which focused on curriculum integration issues, classroom applications, and pedagogical concerns were led by Cornelia Brunner and Margaret Honey from the Center for Children and Technology.

Hayes modems and Prodigy accounts were provided to enable task force members to begin to communicate electronically with one another and with the project facilitators and coordinators. Later, Iona provided Bitnet accounts for everyone. A support hotline telephone number was also provided by Iona,, as were Saturday reinforcement sessions. Numerous written materials, journal subscriptions, and technology conference information were supplied regularly. Evaluation data was collected after each training meeting. Participants completed reaction forms, kept electronic journals, and were interviewed regularly. E-mail communication and other kinds of communication between task force members and the project's director gave a "pulse" on participants' needs, frustrations, and accomplishments. Facilitators and coordinators analyzed the information and made adjustments accordingly.

Sharing sessions were scheduled periodically to enable participants to learn from and support one another. These sessions also provided project consultants a chance to offer assistance from two technical and curricular vantage points. WTEG participants were frequently encouraged to try an alternative or get more training in a particular area whenever necessary. Integration proceeded at various rates and various depths, depending on the individual's readiness level. By Summer, 1993, all fourteen college faculty and all nine classroom teachers were comfortably using technology in connection with their teaching. Only one college representative had dropped out of the project due to a job relocation.

While the levels of use varied widely depending on the content of courses, the teaching or administrative duties involved, and the individual's entry level skills and prior knowledge, every participant advanced beyond a minimal understanding. All participants showed positive attitudes toward technology; some had even become "activists" at their institutions.

A WTEG publication of revised course syllabi representing various content areas of the nine teacher preparation programs will be available for dissemination in 1994. Here we give a summary of its content, selected data about the impact on participants, their courses and the process used to support their work. We conclude with a discussion of the potential for wider institutional impact both within the WTEG alliance and to other teacher preparation programs seeking to integrate technology.

IMPACT

Revised Preservice Courses

All twenty-three participants reported using computer-related technologies regularly. Anecdotal records, projects, sharing sessions, and other means were used to verify their contentions. Since only college faculty were required by the grant to submit course syllabi which reflected how technology was now being used in a required preservice course which they taught, our discussion here will focus on these participants. Table 1 summarizes the variety of courses which were affected:

Table 1
Courses and Number of Faculty Affected

Number of Faculty	**Course Faculty**
3	Social Foundations
1	Philosophy of Education
1	Student Teaching Seminar
1	Psychology of Learning
3	Math Methods
2	Reading Methods
1	Testing and Measurements
1	Technology in Education
1	none (had only adm. duties)
1	moved

Pre-post content analysis by consultants revealed the following changes made by those 10 faculty who submitted syllabi in time for outside review:

Table 2.
Changes Made By Participating Faculty

Number of Faculty	Kind of Integration **(using a 3 point scale)**
3	under-applied = 1
4	adequate = 2
3	well-integrated = 3

The criteria used for this rating was based on one of the main project goals: to integrate new knowledge, skills, and understandings into existing, required courses. The labels suggest the degree to which college faculty were able to change their syllabi, moving toward a more thorough and meaningful application of technology in course content, assignments, and activities. Observations of teaching were not used in this portion.

Generally, the "under-applied" group included nominal discussion or uses of technology, not requiring preservice student to connect the technology to the course content or activities in a meaningful way. For example, one participant now requires her students to write their papers on a word processor, but does not indicate that she intends to discuss with her students the pedagogical benefits of computer use for revising and sharing information in research and writing. Under-applied syllabi generally suffered from a lack of elaboration as applied to pedagogy. No meta-analysis of technology's use in learning was evident in these courses.

"Adequate" syllabi generally included some type of substantial, technology-rich activity; however, these syllabi often lacked a clear explanation of the relationship the participant envisions between the technology piece of the course and the rest of the court content. For example, one participant indicated that students would use "Toolbook" to create programs, but only after the usual course content was covered. In this context, technology remains an "extra," a "reward," or possibly a disposable portion of the course, rather than an integral part of the process of teaching and learning. Other faculty syllabi in this category suggested exciting projects, such as creating hypertext-based interactive reports, but did not indicate that students would be engaged in any discussion of why this particular medium might be appropriate, or of the design and narrative issues involved in creating hypertext-based, compared to traditional reports. Adequate syllabi also tended not to account fully for the effort and rationale involved in introducing students to new technologies.

The "well-integrated" syllabi were created by faculty who were able to recognize the unique qualities of specific technologies such as videotapes, multimedia, and integrated packages, and use them to the best advantage of the course. Well-integrated courses use technology in such a way as to teach and learn with the power of the technology as well as requiring preservice students to analyze its importance for classrooms and individuals.

Participants

Analysis of interviews with participants revealed that for all of them "successful technology integration" meant that their students will have the opportunity to either work with or learn about a range of different technology based applications. The college faculty were also interested in modeling processes that students will eventually use when they are teaching in classroom situations. Success meant increasing their own level of comfort and expertise with the technology, too. For some, this meant starting with projects that are small and modest in scope. Exit presentations on these technology projects revealed other aspects of the revised courses that were not necessarily evident in the revised syllabi. Five college faculty presented projects that used or created tools to support gathering, sorting, and analyzing project-based curriculum or materials by their preservice students, using existing applications such as Excel or, Paradox, or creating their own applications using Toolbook or Linkway.

All participants reported integrating technology into professional tasks. Both college faculty and classroom teachers now regularly use their computers for practical tasks including writing lesson plans, scheduling, managing their time, creating tests and progress reports. Word processing was being used for all professional writing and presentation materials. One classroom teacher even reported that his class was motivated by his great looking working sheets and looked forward to "the font of the week" used on his assignment sheets. In the CBAM language, most participants had attained at least a Level III (mechanical) or Level IV (routine) use of technology. Two faculty and three classroom teachers went beyond these tasks by creating databases for use in their schools and working with other colleagues in joint projects. In these cases and others, the level of use had gone far beyond the routine and was well into "refinement" and in some cases, "integration" and renewal. At least half of the participants reported attaining this level, although their course syllabi did not necessarily reflect this conclusion.

Nine of the fourteen faculty participants mentioned the length of time necessary to become comfortable with the use of the computers. Many of those who were not experts mentioned gaining a degree of comfort that they had not previously had. Even those faculty who did not classify themselves as using the computer extensively for many things noted that it had helped them enormously in personal productivity related to organizing their teaching. Thirteen of the fourteen faculty involved were excited by the possibilities that technology introduced in terms of teacher preparation. The one remaining faculty member expressed caution about the possible overuse of technology. When faculty were asked what changes they thought computers would make if they were to be thoroughly integrated into teacher education, there was a great deal of visible enthusiasm and articulation about the possibilities.

The majority of the faculty felt that the only reward they had received for participating in the program was self-satisfaction and/or professional development. At two institutions, faculty felt that participation might influence their promotion or merit pay but, almost universally, they felt that few people in their institutions had any real idea what they were doing with technology. Most felt that the administrations of their respective institutions wanted more technology in their programs but were not conscious of the fact that the education faculty were attempting to do just that.

Department

In order to address the question of impact on the participating faculty and on the rest of their departments, interviews were conducted with all the college participants and with the 9 Department Chairs. The structured interview covered three major areas dealing with innovation: recognition of the need to integrate technology; possible obstacles to innovation; and those specific attributes which correlate with the degree of innovation. Specific topics discussed included recognition of need, resistance to innovation, and possible correlations. The latter included: sense of power; influence of Department Chair; concern for recruiting students; influence of fellow faculty members; influence of administrators; financially dependent on attracting students; number of tenured faculty; whether Chairs are appointed or elected; interaction between faculty; teacher evaluations; complexity of innovation; and ability to try innovation on a limited basis.

In examining the change in ability to use the technology, it was found that there was no correlation between that ability and the recognition of the need to integrate technology, the possible obstacles to innovation, or those specific attributes which correlate with the degree of technology. Contrary to the research literature, there was no relationship between the years of experience, years that the Chair was present, the reward system, the percent who were tenured, or any of the other items listed. There were, however, some statements that were repeated by many of the participants that deserve examination. Without exception, everyone, no matter at what level they were, mentioned lack of funds, lack of adequate staff, and lack of adequate equipment.

Institutionalization of Change

The question of the degree of concern regarding integration of technology throughout the full teacher preparation curriculum of the specific schools was addressed by examining the "concern about innovation" as defined by Hall et al. (1986, p.7):

0. AWARENESS
1. INFORMATIONAL
2. PERSONAL
3. MANAGEMENT
4. CONSEQUENCE
5. COLLABORATION
6. REFOCUSING

Transcripts of the interviews with all fifteen of the participating faculty were examined and, for reliability, rated independently according to Hall's categories by three college faculty professors, one each in education, science, and computer science. Because the scale used above is not continuous, inter-coder reliability was calculated using the mean difference. On a scale of 0 to 6, out of 15 interviews, 9 were coded identically by all three readers. The mean difference between the readers were 0.27, 0.33, and 0.40 resulting in an average mean difference of 0.33.

An examination of the levels of concern of participants grouped by institution shows some differences. Institutions A, B, and C had all been recipients of other grant moneys for hardware but not necessarily specific to the education departments, so that they had relatively more access to equipment. In these institutions, all of the participating faculty had access to computers in their offices. These were not necessarily new, or even necessarily compatible with the computers given them to use at home for the project, but they were available. The faculty from these colleges also noted that supplementary instruction was readily available at their own institutions, primarily from the college Academic Computing areas. It is also interesting that only participants in institutions A and B felt that the work they had done in learning technology so that they could integrate it into their curriculum would bring them rewards from the college system, in the sense of having that work recognized for promotion or tenure.

Institution A had the largest number of participants, suggesting that the effect of training a critical number of faculty may enter into the eventual institutionalization. Another difference in that institution was that all of the interviews with faculty mentioned the fact that there was a specific faculty member who had been responsible for assisting them, getting a graduate assistant to help, working with the administration to overcome obstacles, and working with the Academic Computing group to help overcome small problems. That individual was assigned this task of helping to integrate technology by the college administration, and given some release time to do so.

Implications

It would seem that the training given to the education

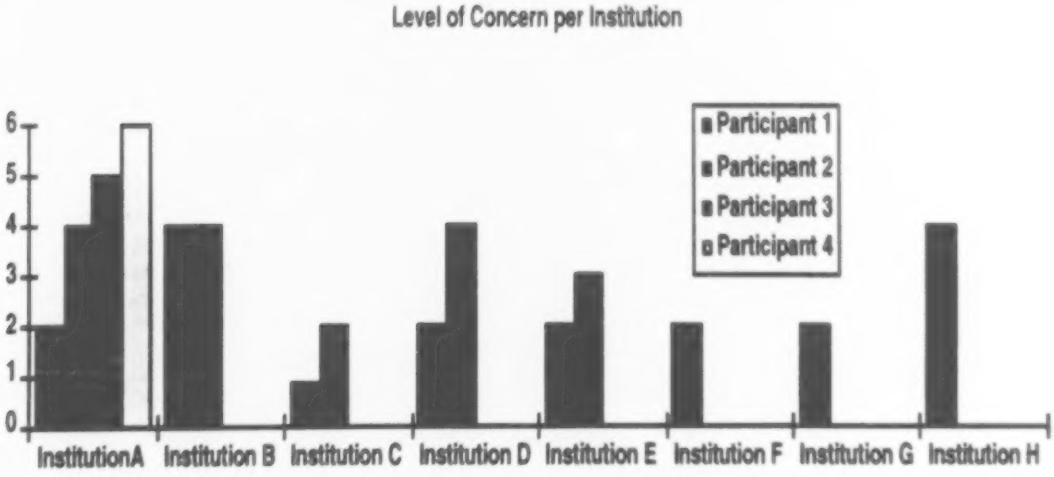

Figure 1. Levels of Concern

faculty in all 9 colleges has certainly increased their individual capabilities. It is also obvious that more time and more training will be necessary for those who started with less experience, to become more adept and to branch out to new uses. Whether they will seek that training on their own, without the release time which this project afforded, remains to be seen. Certainly, at this time, the enthusiasm remains high and it must be remembered that only two year has passed since this project began.

The discussion up to this point has centered on the individual professor but there were college-wide changes that came about because of the focus on technology in teacher education and the recognition that it is becoming an important part of teaching and learning. One college used the computer given to the participant as the focus of a new curriculum classroom. It was primarily the fact that this computer would be accessible to students that persuaded the college to designate one room as the curriculum classroom. A second college has placed a renewed emphasis on a Master's degree in Learning Technology and is once again examining the curriculum and management of that degree program. Another college has included technology in their planned building and expansion program for their education department. There is certainly a renewed and expanded vision of technology and education throughout the colleges that have participated in the program.

Given the fact that funding for technology in teacher education will remain a problem for the foreseeable future, what can be gleaned from this project which might further facilitate the faculty development and promote technology integration within programs?

- Faculty who are using the computers to a greater extent mentioned easy access as very important to their own lesson planning, even if the computers available for office use were mostly old and outmoded and did not match the ones given them for home use.
- The ease of integration into the teacher education program seems to be accelerated when there is one individual assigned the responsibility for dealing with all the necessary parties such as the administration, the faculty, the academic computing support team, graduate assistants, etc.
- It is possible that having a critical mass of faculty involved facilitates matters.
- Training alone is not sufficient unless the college administration also makes it evident to the faculty that their participation is important, and will be supported and recognized.

An examination of all the data collected suggests the beginning of an emergent model that might be of interest to institutions looking for a more efficient way of training faculty to integrate technology. The model would include the following elements:

1. Any new program attempting to change teaching should have evident support from the administration; there is a need for direction and purpose from the administration, both at the University and the Department level. The administration has the responsibility of working with the faculty to develop an overall vision of how technology should be incorporated. The development of that vision can take place concurrently with initial training but should drive the monetary outlay.
2. Given the amount of effort expended in learning how to use technology, the administration must also incorporate some system of recognition for the faculty.
3. There must be some funding put aside to provide computers for the faculty in their offices. Contrary to the faculty expectations, these do not have to be "state of the art." The initial work done by those faculty who were just beginning was primarily word-processing and older, rededicated machines can be used for this, as well as for telecommunications. However, as faculty become more proficient, part of the reward system should include the possibility of upgrading to computers capable of handling more sophisticated programs.
4. There needs to be a deliberate effort made to bring together the disparate parts of the college who have an interest in technology. In many cases in this study, resources did exist but there was no central group that knew of their existence. Resources can and should be shared; a computer classroom can be shared rather than be dedicated exclusively to every department, with the administration taking the responsibility of creatively scheduling classes so that more than one department has access.
5. Fairly immediate help has to be made available and it must be both efficient and non-threatening. Many of the faculty spoke of the frustrations in getting any kind of assistance and many wanted a telephone hotline at their own colleges so they could request help and ask questions. Again, there was often more training available in the institutions than the faculty took advantage of, either because they were not cognizant of the training, because they felt it was poorly done, or because broadening their own expertise in this area was not a priority item since there was no reward for doing so.
6. One individual must be given the responsibility for coordinating change. The most successful institutions were those where an individual felt that getting other faculty to use technology was his or her responsibility. In this particular project, the responsibility was focused primarily on individual change and most institutions did not designate any responsibility to one individual participant. However, in the absence of a change agent, a critical mass of department faculty who are learning new technologies would help to promote change.
7. Finally, our informal use of the CBAM model suggests that departments or divisions attempting to train faculty and integrate technology will find in it a useful set of developmental milestones for supporting faculty and pushing the boundaries of technology's level of use until

such time as these innovations becomes part of faculty's working environment and their way of thinking about teaching.

The WTEG experience with 9 departments of education further suggests that third parties, such as the Westchester Education Coalition, can play a pivotal role in facilitating professional developmental efforts designed for the needs of teacher education programs and faculty. It also suggests that amount of time and support that training faculty and promoting curricular integration requires may still be greatly underestimated by individuals and institutions alike.

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Teaching Future Teachers to Enhance Teaching and Learning with Technology

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Although it is widely recognized that effective computer use can vastly enrich the educational process in our schools (Behrmann, 1988; OTA, 1988; Sheingold & Hadley, 1990) and that assistive technology has the potential to dramatically improve the lives of people with disabilities (Church and Glennen, 1992; Enders & Hall, 1990; Lewis, 1993; and Male, 1994), many children are not yet benefiting from the computer revolution. In many schools "computers are out of reach or used in tragically misguided ways" (Branscum, 1992, p. 83). As Lamar Alexander, former U.S. Secretary of Education, has stated, American public schools are "the last institution in society to be almost untouched by technology" (quoted in Kondracke, 1992, p. 232).

One of the reasons computers have not yet revolutionized the educational process is that many teachers have not been adequately trained in appropriate applications of computer technology (Blackstone, 1990; Hasselbring, 1991; Niess, 1990; Panyan, Hummel, & Jackson, 1988; OTA, 1988). Colleges and universities continue to produce teachers who do not have the skills needed to enhance curriculum and instruction with computer technology (Beaver, 1992; Thomas, 1991; Turner, 1989). Although faculty in teacher education programs are aware of this problem (Blackhurst & MacArthur, 1986), they need help in making the major curricular changes which technology-integration demands.

Characteristics of Effective Technology Training

Conventional methods of instruction in higher education - namely, lectures and discussions - while effective for other topics, are not adequate for establishing the level of skill needed to implement educational technology effectively (CSET, 1991). Nor is the common practice of requiring a "computer literacy" course of all education majors, since such courses tend to focus on the mechanics of computer use rather than on the essential link between technology and curriculum and instruction (Panyan, et al., 1988; See, 1992). Turning non-computer-users into skilled and enthusiastic computer-using teachers requires a special kind of training, and therefore, preservice programs need to undergo a special kind of curriculum revision. Characteristics of effective technology training and curriculum revision are found in the literature:

1) Educational technology training needs to be integrated into the entire teacher preparation curriculum, not taught in isolation, so that effective technology integration is modeled for pre-service students (Edyburn, n.d. ; Niess, 1990; Strudler, 1991; Wissick, 1992). This also provides students with multiple opportunities to practice their new computer skills and addresses the problem expressed by skilled computer-using teachers that mastering computer-based practices and approaches takes a great deal of time (Sheingold & Hadley, 1990).
2) The training must link technology with the instructional process and the curriculum. It must emphasize that technology is not an end in itself but rather, it is a means to an end — which is the enhancement of teaching and

learning. Educational technology needs to be matched to the curriculum and tied into the principles of effective instruction (Fazio & Polsgrove, 1989; Hasselbring, 1987; Panyan, et al., 1988; OTA, 1988; See, 1992).

3) The training needs to be hands-on (CSET, 1991; Roseman & Brearton, 1989). Lecture/demos of "what computers can do" are not adequate. Teachers need to use the hardware, software and assistive devices - not watch them being used - and become comfortable with them. They also need to participate in supervised field experiences that take place in practicum that use technology effectively.
4) The training needs to be in-depth. The hands-on training activities need to move students from a simple awareness of technology applications to higher levels of knowledge and computer-using skills (CSET, 1991). Teachers need to become comfortable enough with computers so that they can learn to make decisions regarding the selection and use of hardware, software and assistive devices based on students' individual needs.

How to Infuse Technology into a Teacher Education Curriculum

Step 1 - Decide What Needs to be Taught

The first task undertaken in the Trenton State College Special Education Curriculum Enhancement Project was the development of a list of Competencies in Instructional and Assistive Technology, which are the skills needed for graduates of the program to be effective technology-using teachers (Blackhurst, 1990). Rather than being generic skills which would apply to all educators, these competencies were designed to address the particular conditions facing special education teachers in New Jersey's schools; they were written for classroom teachers who need to be effective technology users, not programmers or computer coordinators, and for teachers who need to be self-reliant since few school districts in the state provide on-going technical support.

The emphasis is on functional skills needed in the classroom , not on "book knowledge." The authors believe that there are no prerequisite skills to using a computer, and therefore, the competencies do not include rote learning tasks such as identifying parts of a computer or defining technology terms. The vocabulary will come later, after students have actually used computers, after they have been captivated by the magic.

The focus of the competencies is on people, on making decisions about people's use of technology, not on the razzle dazzle of the devices themselves. The ultimate goal of technology training is to have teachers who are able to determine the match between students' curricular needs and the technology options, and to link the use of technology with effective teaching practices, (CSET, 1991; Hasselbring, 1987; Panyan, et al., 1988; OTA, 1988). The competencies emphasize the role of the teacher as a collaborator with parents and related services personnel in the selection and integration of technology (Church and Glennen, 1992), and the need for teachers to be aware of and to seek out a wide range of resources since they need to function fairly independently in their classrooms (Sheingold & Hadley, 1990).

The list of competencies at Trenton State College stems from a review of the literature, a review of other published competencies (e.g., Blackhurst, 1990) and anecdotal reports of practices that have been effective (and ineffective) in the field. To validate the list, a survey was sent to 40 teachers, parents, and technology trainers who are actively involved in using instructional and assistive technology. They were asked to respond to each competency using the following matrix: (+)=Very Useful, definitely needed, (U)=Useful but not essential, (-)=Not Useful, recommend changing or removing. In addition, they were asked to add any skills which they feel were missing from the initial list. When all of the validation surveys were returned, the suggestions of the experts were incorporated into the final list of competencies. The competencies are divided into six clusters: 1) enhance curriculum and instruction of individuals with disabilities through appropriate use of computer-based instruction, 2) make a computer accessible to individuals who have physical, sensory, perceptual, and/or attention disabilities, 3) enhance the communication abilities of individuals who have disabilities which interfere with effective communication through the appropriate use of augmentative communication systems, 4)use simple technology to increase the independence, participation, and inclusion of students with severe disabilities, 5) follow through on plans for integrating instructional and assistive technology in the classroom by identifying areas of need and taking appropriate action, and 6) enhance the completion of non-instructional professional responsibilities through the appropriate use of computers.

One problem with developing this competencies list is that the field of instructional and assistive technology changes so rapidly that a major revision of the initial list was needed only three years after it was developed. (This revised list is now undergoing the validation process described above.) This is unavoidable, however, if the list of skills is to be detailed enough to lead to meaningful instructional activities. of the pitfalls of technology that just has to be acknowledged and dealt with.

Step 2 - Develop a Plan for Infusion

Once a list of educational technology skills has been developed, they must be matched to existing courses. A second list needs to be made - that of all the courses which are required of education majors in the order in which they are taken. The two lists then need to be placed side and side and questions need to be asked: Which competencies are relevant to which courses? Is there any essential sequence to teaching any of the competencies? How much additional material can a course accommodate? Which faculty are most interested in adding a technology component to their courses? The process of matching competencies to courses is much like completing a jigsaw puzzle; one tries a few arrangements, saves those that fit, and discards those that do not fit well. After a few tries (and some debate) a systematic plan will emerge which distributes the priority technology topics across courses. The resulting document, called the Plan for Infusion, serves as a blueprint for the entire curriculum revision process.

For example, at Trenton State College (TSC) it was decided to infuse the competency cluster "Make a computer accessible to individuals who have physical disabilities and/or sensory impairments" into a required course taught second semester junior year called Nature/Needs of Students with Multiple Disabilities. This course already dealt with adapting teaching materials for students who could not see well or hold a pencil, so it was not much of a stretch to add a unit on adaptive inputs and outputs for computers. These competencies are highly relevant for this course, and the course is offered late enough in the program so that students will have been introduced to computer-assisted instruction in previous courses. Similarly, the topic Data Collection and Analysis fits well into a course on Behavior Management, and Facilitating Writing with Computers fits perfectly into the course Nature/Needs of Students with Learning Disabilities.

No two Plans for Infusion will be exactly the same because every teacher education program has its own idiosyncrasies. For example, in the special education program at TSC, using drill and practice software as a method of review is introduced in a course on Remedial Reading. This is because this course is taught early in the program (sophomore year) and because most drill and practice programs which focus on reading skills are relatively easy to use. The following semester when special education majors take Curriculum and Methods for Teaching Individuals with Disabilities, they are ready to tackle more complicated topics, and the competency cluster, "evaluate and select software which is appropriate to the curriculum and to students' individual needs," has been infused into that course. Since the previous course focused on reading software, the curriculum course emphasizes software to teach other subjects.

Step 3 - Develop Training Activities

In order to "insert" the technology topics into the selected courses, a series of Technology Training Modules need to be developed. The Technology Training Modules are detailed lesson plans for the infusion of the technology topics into existing coursework. The amount of detail is important because the goal is to produce modules which can be used by whomever is teaching the course. The earliest models of effective technology modules were developed by COMPUTE (Coalition of Organizations in Michigan to Promote the Use of Technology in Special Education, n.d.) and FDLRS/Tech (part of Florida's teacher resource centers network, 1989), but both of these training packages were designed as stand-alone in-service materials and cannot be easily adapted for pre-service programs.

An outline for preservice Technology Training Modules was developed and revised at Trenton State College. Key components include a list of the competencies addressed, a rationale for the topic, detailed suggestions for class activities, and instruments for evaluating both student performance and the modules themselves. The premier feature of each module is the hands-on activities which emphasize collaboration, decision-making, and the critical relationship between technology use and effective instruction. The hands-on activity can be an in-class workshop and/or an out-of-class assignment; it varies depending on the course, the topic, and the equipment needed. The guiding principle is that the hands-on experience engages the students, captivates them, and does not allow them to hide behind passive note-taking.

Sample Technology Module. For example, a module on Access to Computers which was developed for the course Nature/Needs of Students with Multiple Disabilities, features a hands-on round-robin activity. Six to eight computer stations are set up, each equipped with different assistive devices. Adapted inputs used include IntelliKeys (an expanded keyboard), the Touch Window, the Muppet Keys, a keyguard with headpointer, a single switch with an interface set for scanning, two switches with an interface set for Morse Code, and Voice Navigator. Adapted outputs used are large fonts and synthesized speech. Working in pairs or small groups, students proceed from one station to another, exploring the adaptive inputs and outputs, discovering their special characteristics, and discussing who is likely to benefit from their use. Written instructions are provided next to each station to decrease technical problems and increase student independence, and at least one graduate assistant is enlisted to help when technical problems arise.

Resources. Since the field of computer technology changes so rapidly and, as a general rule, equipment is expensive, it is difficult to keep a program's resources completely up-to-date. Therefore, an important feature of technology integration initiatives is to establish close working relationships with schools and/or non-profit organizations in the state who are willing to share their collection of hardware, software, peripherals, and assistive devices with a teacher education program. Most states have a computer resource center that is part of the Alliance for Technology Access (ATA), that may be willing to loan software and assistive devices for the purpose of training activities (especially if the lending works both ways).

A second helpful resource is an Advisory Committee. Consisting of teachers and parents who have been using technology in exemplary ways, an Advisory Committee can provide input from the field on the most current uses of instructional and assistive technology, problems in implementation, and training needs. In the authors' experience, computer-using teachers and parents are pleased to see a teacher education program provide technology training and therefore are willing to help. This interest is leading TSC toward having parents guest lecture as part of the Technology Training Modules; the parents have agreed to tell their stories in classes so that teachers will understand the very personal impact technology can have on children with disabilities.

A third helpful resource is practicum sites which use instructional and assistive technology in exemplary ways. The Advisory Committee is a good place to start identifying these sites. It is essential that cooperating teachers hold a special interest in using computers to enhance curriculum and instruction. While many such teachers exist, it is difficult finding the large number needed to accommodate all the students enrolled in practica.

Additional Learning Opportunity

An extracurricular activity which has enriched many students' technology experiences at TSC is the student magazine TECH-NJ (Technology, Educators, and CHildren with disabilities-New Jersey). This 20 page publication is written primarily by students in special education with contributions from faculty and students from other disciplines. It is designed to provide students with additional training opportunities while serving as a resource for computer-using teachers and parents in the region. Each issue contains software reviews, profiles of area programs which demonstrate best practices in computer integration, and at least one "Personal View" article that highlights the impact computer technology has had on a person with disabilities.

Benefits of TECH-NJ Activity

By visiting classrooms that use technology and by interviewing users personally, the student writers gain additional in-depth experience with instructional and assistive technology which cannot be matched in the college classroom. The students meet and witness children and teachers confronting real problems and finding realistic solutions that work.

One further benefit from the TECH-NJ activity is that the publication forges connections between the TSC teacher education program and area schools which use educational technology in exemplary ways. This is one way to expand the list of appropriate practicum sites for students.

Looking Ahead

A promising development at TSC is that recent graduates of the special education program who are securing teaching positions in local school districts are quickly being recognized for their expertise in educational technology. Perhaps these new teachers will show by their example the value of educational technology. Perhaps they will succeed in capturing the interest of their colleagues and will then be in a position to teach them how they too can enhance teaching and learning with technology.

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Preparing Preservice Teachers to Use Information Technology for Classroom Management

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The large variety of information technology systems available today can help educators accomplish classroom management tasks more efficiently and effectively. This paper describes how early elementary preservice teachers can discover and use different types of information technology to accomplish classroom management responsibilities. Descriptions are given for the use of software programs in eight different areas of classroom management. Software is demonstrated and discussed. Hardware questions are addressed. Information is presented under the umbrella of two clinical experience workshops. One workshop investigates the use of multimedia and the other workshop examines the use and selection of shareware.

When technology and education are mentioned, there is usually a discussion on how information technology will or should change the way students learn. Some educators envision the use of technology in the context of the 20th and 21st century American school system. This vision includes the use of information technology in all aspects of school life, including the management of the learning environment. Management consultant Levinson (1990) writes of school scenarios that include computer work stations where teachers can "customize instruction, maintain contact with parents, and handle administrative chores" (p. 121). Similarly, director of the Institute for the Transfer of Technology to Education, Mecklenburger, (1990) points out that "with the right devices and software, a teacher (or a schoolful of teachers) can better organize clerical work and increase the time available for planning learning, and teaching" (p.106). The images produced by these two authors include the management as well as the instructional responsibilities of teachers. The implication of these perceptions is clear — teachers in modern learning environments must be prepared to know about technologies that can assist with instructional as well as managerial responsibilities.

Much of the responsibility of preparing preservice teachers for the demands of modern schools is undertaken by teacher education programs. Presently, teacher education programs are trying to present technology information and to develop technology experiences that will best meet the preparation needs of the preservice teacher. How much and what type of technology training are questions that still must be answered.

Teacher educator Harrington (1993) perceives that "numerous educators think that preparing teachers to use technology effectively should be a significant goal of teacher education programs...." (p.5). This author also raises questions about how preservice teachers are prepared to use technology in the learning process. It is relevant to address the same concern about how preservice teachers are prepared to use technology for classroom management purposes when implementing technology training into a preservice teacher education program. Classroom management tasks must be defined and information technologies to address these tasks must be carefully chosen.

The following is a description of two clinical workshop experiences designed to help early elementary preservice teachers discover and use various types of information technology to accomplish classroom management responsibilities. These responsibilities include: (a) communications, (b) record keeping, (c) lesson planning, (d) project management, (e) curriculum development, (f) professional development, (g) room decoration and organization, and (h) developing learning center materials.

Program Description

Two clinical workshop experiences were developed for preservice teachers enrolled in a senior level, early elementary (K-4), classroom management course at Eastern Kentucky University. Students in this teacher education program must demonstrate competence in word processing, database, and spreadsheet usage by completing a prescribed course of instruction or a college developed test at a proficient level. Therefore, the purpose of these workshops are focused on providing students with experiences that supplement the mandated competencies as well as demonstrate how information technology can directly assist in classroom management duties.

These workshops were designed to accommodate time and equipment limitations; information is presented in a very compact and simple format. The hardware and software chosen for these experiences represent those systems and programs that are inexpensive, easily used, and that are commonly found in classrooms. Software is demonstrated, classroom management applications are discussed, and points of interest about hardware requirements are addressed.

Using Multimedia

A fun way to start this clinical experience is to play an audio compact disc by using a CD-ROM disc player. Students are very surprised that some of their favorite music can be produced by a personal computer. It is necessary to explain that hardware peripherals and adaptations are needed in order to enable the computer to execute multimedia programs. Details about types of CD-ROM disc players, speakers, video cards, audio cards, and the use of head phones are discussed. Students often conclude that the use of an audio disc can serve as a transition cueing mechanism or as part of an integrated learning activity.

Playing the audio disc acts as a springboard for discussion on how the use of CD-ROM multimedia programs can assist in the management of a classroom. It is explained that many educators recognize the interactive nature of multimedia programs as supporting a more authentic learning environment (O'Neil, 1993). Demonstrations are given of interactive story and encyclopedia programs. Students observe how the user can electronically control information that includes text, video, and sound. Such programs can greatly assist in the development of meaningful learning centers and in the planning of integrated thematic units. Some multimedia programs can record responses or student work, assisting the teacher in analyzing the progress of each student.

Other types of CD-ROM programs can be discussed or demonstrated to represent a wide range of practical applications. These types include: (a) atlases for reference and professional development, (b) games and simulations for learning and practice activities, (c) time tables of history for unit and lesson planning, (d) sound libraries for unit and curriculum development, (e) graphics for communications and room decorations, and (f) reference information programs for professional development.

Using and Selecting Shareware

A laboratory with at least one computer per two students is needed for this clinical experience. Students are given a variety of shareware programs and a review guide. Working in partner groups, students are given several programs, asked to review them, and then share the results of the reviews with the rest of the class. At least 20 different shareware programs are used for this experience. These programs address the following classroom management tasks: (a) record keeping, (b) written and graphic communication, (c) learning center materials, (d) daily news information, (e) project management, (f) lesson planning, and (g) room decorations. The software programs are passed from group to group as they are reviewed.

The review instrument contains questions about software publication information, registration procedures, menu data, hardware specifications, and classification of classroom management tasks. Based on this review information, students are asked to determine if the program would be recommended for use in an early elementary classroom. After reviewing several programs, the students share information, recommendations, and reasons used for determining the recommendations.

Activities and discussion during this clinical experience address four major purposes. The first purpose is to help students experience a wide variety of types of programs. Hopefully the students can begin to understand that a vast amount of software is available for use in the education profession. A discussion about copyrights, public domain, and shareware addresses the second purpose of this clinical experience. It is necessary for preservice teachers to learn about legal and ethical issues relative to the use of software. The third purpose is to assist preservice teachers in developing practical review habits. It is often necessary for teachers to first carefully review software programs before recommending them for adoption. The fourth purpose of this workshop is to alert the students to recognize hardware requirements. Some of the programs require peripherals such as a mouse, a CD-ROM player, a VGA monitor, a specific type of printer, etc. Students should become aware that many times hardware specifications determine the compatibility of a program to the system.

Conclusion

As teacher education programs prepare students to become classroom teachers, careful planning must be done to select appropriate experiences in the area of technology training. If classroom management tasks are to be addressed, definitions of these tasks should be made and technology experiences should be chosen that best match the needs of the students. Practice in using, reviewing, and making decisions should be incorporated into clinical experiences. A variety of software and hardware should be an important part of these experiences in order to present a spectrum of possibilities for possible use in the classroom.

Although multimedia and shareware were featured in these two clinical workshops, the emphasis was placed on having experiences with varied types of software, discussions that link these experiences directly to fulfillment of classroom management tasks, and awareness of hardware questions or concerns. For those students who had already acquired some computer proficiency, these workshops experiences led to discovering how to use technology for classroom management. For those students with little or no experience working with computers, these workshops were almost overwhelming. Software applications were easily understood but discussions about hardware specifications were perceived as "techno-babble". Therefore, careful planning must be done to arrange technology experiences in a manner in which all students can participate. No matter what level of computer expertise a student may have, the effective and efficient use of information technology for classroom management purposes can and should be obtained.

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Developing Technological Skills and Applications with Social Studies Preservice Students

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The ways in which we prepare teachers are rapidly and fundamentally changing in both structure and instruction. Many of these changes are rooted in new ways of generating, storing, communicating, and using information. As we shift from the Industrial Age to the Information Age, new training paradigms are emerging. In part, this means that those of us involved with the preparation of teachers will have to engage in developing information acquisition skills more and more of the time.

Computer and communications technologies are the dramatic and visible signs of this revolution. Thus, these technologies have become the focus for many educators seeking to adapt schools to this new age. Increasingly, parents, teachers,and children believe that by learning about computers and technology and by learning how to use computers, they will be better prepared to survive and to enjoy economic well-being in the changing world.

Information technology offers new opportunities for children and their teachers to be creative, to throw off the drudgery of the old curriculum, to invent new ideas and new means of expression, and to tackle more interesting and complex problems.

Using Computers in the Social Studies Classroom

Within the broad context of social studies preservice teacher preparation programs, computer technology has become an important component in providing perspective educators an avenue for learning how to:

- develop a sense of social responsibility for their students
- strengthen student decision-making skills
- provide a venue to teach information retrieval skills
- increase student understanding of the impact of technology, bothhistorically and in the future

Teaching these concepts through the use of simulations, role playing, games, or using data bases on computers is not only feasible, but it can be ongoing.

Although learning from computers is useful in social studies, perhaps the most interesting and valuable use of computers as an instructional tool is in learning with computers. Learning with computers involves simulations and problem solving. Simulations model either hypothetical or real events,and can be either structured or unstructured in the decision outcome. Problem solving involves using computers to store, retrieve, and analyze data. The heart of learning with computers for problem solving consists of managing information. This can be done by using software that files information, employing word processing programs, and making use of data bases.

Example-Election Projection

During a recent presidential election, a preservice social studies methods class became interested in developing an instructional unit that would teach high school government students how pollsters develop and use polling techniques to project election outcomes. Using a multimedia platform that included a computer, CD-ROM and laser disk players, not only was the class able to simulate how groups do their

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polling, but it was also able to project the outcome of the local election accurately.

First, the students developed a series of questions to ask potential respondents. They were gleaned from items used by newspaper and magazine polls. Next, they divided the city into tracts, using data from the most recent census. Teams were assigned to certain blocks. Households were then selected to be interviewed by teams of students. These interviews were videotaped and later integrated within the multimedia presentation.

While this was taking place, other students were assigned the task of writing a computer program that would use the data being collected to project the sample onto the city as a whole. Working in groups, they were able to complete the task.

In this project, the computer was used as an analog to ongoing classroom activities. It served as an information storehouse, a data analyzer, and an arbiter of decisions. More importantly, it acted as a mechanism for solving a problem.

This example shows the potential for using computers in social studies classrooms. For the first time, teachers can use all types of original databases, from voting records to list of historical battles, within their classrooms. Besides performing higher cognitive functions, the computer can also help in teaching geographical place-names, group skills, and basic factual information.

Social Technology Issues

Besides using technology in a traditional instructional manner, preservice social studies teachers need to learn how to incorporate the moral and ethical issues surrounding the use of computers and the information generated by them. Within this context, social studies classroom will have a large role to play. The values and attitudes needed to cope with the so-called "information explosion" will determine how we educate our society about computers and whether or not we manage this technology properly.

Many social studies classes already discuss the nature of privacy in society. This type of discussion will become more relevant as information about us and our personal affairs is stored in computer files. Who has the right to this data? Can individuals or the government collect items about us without our knowledge? How will the computer change our lifestyles? These kinds of queries need to be examine within social studies classrooms.

Below are examples, by grade level, of ways that preservice teachers might take information about computers and technology and integrate it throughout the social studies curriculum:

Kinder: Become aware of the existence of computers in homes and schools.
Grade 1: Learn about the actual uses of computers in homes and school settings. Study the influence of computers on family and school life and compare with family and school life in earlier times. The ethical issues at this level involve consideration of others' rights to use computers.
Grade 2: Learn about the uses of computers in the community, such as in stores and in banks. The ethical issues at this level involve respect for laws which protect people from computer abuse.
Grade 3: Learn about the uses of computers in government and business or industry. The ethical issues at this level involve respect for individual privacy and laws which protect people from computer abuse.
Grade 4: Learn about the uses of computers in other nations. Again, the ethical issues at this level involve respect for individual privacy and laws which protect people from computer abuse.
Grade 5: Learn about the history of computers as part of the industrial/information revolution. The ethical issues related to individual rights to privacy might be discussed.
Grade 6: Learn about the history of computers as part of the industrial/information revolution in the world. The ethical issues related to rights to freedom and civil liberties are useful examples.
Grade 7: Learn about the economic impact the computer and technology industry has had in one's state.
Grade 8/9: Learn about the development of technology throughout the history of the United States.
Grade 10: Learn about the information revolution as a world-wide phenomena.
Grade 11/12: Learn about the economic and governmental changes brought about by the mid-twentieth century microtechnology revolution.

Preservice teachers need to be shown that technology can serve as an educational tool useful to both teacher and student. The combination of technology and teacher interaction can provide a diverse learning environment than will not only deliver instruction in a eclectic format, but provide students with a window to how technology is, and will continue to, affect their lifestyles.

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An Innovative Collaborative Initiative: Logo, Fifth Graders, and Preservice Education

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What do fifth graders, Logo, preservice teachers, and problem-solving have in common? On any given Wednesday morning from September through May, they all may be found in the College of Education Microcomputer Laboratory at the University of Montevallo in central Alabama. What began as a service project to supplement the local elementary school's computer literacy efforts in 1983 has evolved into an integral curricular component in the fifth grade mathematics program and a credit course in technology for preservice education students involving two or three university faculty members.

This collaborative microcomputer literacy experience was formulated by the University of Montevallo and the Montevallo Elementary School of the Shelby County, Alabama, Schools. Collaboration implies discrete units working together in an educational endeavor, and the importance attributed to such a public school/university partnership has been affirmed by national professional organizations such as the American Association of Colleges for Teacher Education (Ashton, 1992). Potential benefits for teacher education include a shared sense of purpose and new structures for reflective evaluation. Support for the reflective teaching model spans pedagogical theory from Dewey (1904; 1933) to the present (Pultorak, 1993). According to Shulman (1986), the transformation of subject matter for teaching occurs as the teacher critically reflects on and interprets the subject matter. The Montevallo collaborative program incorporates this model by placing the preservice students in a position to observe; assist with teaching; and then, through weekly journal entries, to reflect on the teaching/learning process.

Along with their teachers, fifth grade students walk to the Microcomputer Laboratory where they are instructed in the Logo language by College of Education faculty. The preservice students observe, assist, and teach the children. This situation allows the preservice teachers to interact with the children and the inservice teachers, as well as the computer. The preservice course content includes other components of computer-assisted instruction (CAI) and computer-managed instruction (CMI) with an emphasis on Logo and its impact on the cognition, problem-solving ability, and social interaction of the fifth graders.

Effectiveness of Logo

The fifth grade instruction utilizes LogoWriter software based on the Logo computer language developed in the 1970s at MIT by Seymour Papert and others. Logo utilizes turtle geometry, mathematics designed for exploration. Turtle geometry is computational, using a dynamic "turtle" which has a heading and accepts typed commands, a different style from Euclidian or Descartian (Papert, 1980). According to Papert, all children are capable of complex thinking and problem solving if they are provided with appropriate vehicles, and he identified Logo as such a vehicle. Logo was designed to offer students flexibility in approaching, attacking, solving, and drawing conclusions from given problems. Additionally, Logo can provide students with the opportunity to make abstract concepts concrete. In seeking means to assist students with the transfer of problem solving skills, Martin and Hearne (1990) analyzed Papert's Logo principles as the following strategies: a) breaking problems into manageable subproblems; b) systematic planning of actions to achieve goals, or means-end analysis; c) "debugging," the process of successively revising solutions; and d) developing a more positive attitude toward errors and their corrections.

The ability of Logo to improve students' thinking and learning has been extensively investigated and the results of these studies have been considered in the development of the Montevallo program. The focus of the Logo instruction is problem solving. The activities on the computer provide the students with the basic primitives needed to create designs, with attention to principles in their geometry curriculum. However, they also are encouraged and allowed time to explore and develop new designs and to correct and debug their procedures rather than "clearing graphics" without analysis of the problem.

A research project at Iona College suggested that through Logo experiences students learn to analyze and segment problems and create solutions logically. As procedures are developed, students organize sequentially, consider different perspectives, and modify their ideas based on their own evaluation (Allocco et al., 1992). Results of studies at Kent State University supported the theory that Logo helps students construct more abstract and coherent concepts. The technology which permits interaction with Logo allows students to manipulate ideas and reflect on them to construct their own personalized concepts (Battista & Clements, 1990).

Ernest and Rohm (1985) investigated the implications of Logo on the problem-solving ability and geometry achievement of seventy-six public school fifth grade students. The Social Sciences Piagetian Inventory (SSPI) was utilized to assess problem solving, and a researcher-developed instrument measured geometry achievement. The control group received CAI and the experimental group received Logo instruction in the same location for the same time period. The results indicated that Logo instruction seemingly is an effective means to increase achievement on selected geometry tasks and may improve actual progression from one stage of cognitive development to another.

Nastasi, Clements, and Battista (1990) found that in comparing Logo instruction and CAI of fourth and sixth graders, the Logo instruction caused greater need for collaborative decision-making, enhancing the development of problem-solving skills. The social interchange of the children centered on the resolution of cognitive conflict. Due to the less structured and more discovery-oriented nature of the Logo exercises, the Logo environment is conducive to social interaction among peers. The study also indicated that the Logo sample students "evinced significantly more expressions of pleasure" (p. 157) related to the results of their Logo work.

Program Description

These and other research studies support the use of Logo in the University of Montevallo program. Initially, students gain knowledge of the functions of the hardware and means of control of the system, including memory, peripherals, and input and output devices. Skill in the operation of the system is mastered. Logo instruction utilizes the turtle graphics function as guided discovery techniques are implemented to allow the students to learn the turtle's capabilities. After structured procedures are learned, creative exploration is encouraged to enhance the students' problem solving/critical thinking skills. On alternate instructional days, students are involved in reinforcement activities such as calculator exercises, art lessons, journal writing, simulations, and other hands-on activities organized in a center format. Activities in the center include journal questions that cause the fifth graders to "reflect on what they doing," a technique supported by Allocco et al. (1992).

The design and purpose of the plans used with the fifth graders at the University of Montevallo seem consistent with the instruction directed by Clements and Battista (1990). In both situations, the students are directed to analyze the properties of the geometric shapes, to discover how the components are put together to form the shape, and to identify similar properties. For example, in the Montevallo program, rather than providing the students with the commands to create a square, they are given time to create one on the screen themselves. Discussion follows which allows them to discover the pattern and the similarity of the properties of each side and turn. After this analysis, they are given the mechanics to write the commands as a procedure. Teaching procedure creation in this manner encourages the students to make connections between the commands in the procedure and the corresponding drawings of the shape created by the procedure.

Fifth Grade Lesson Plans

An important component of each lesson is presenting the students with a challenge, ranging from discovering the measure of the width and length of the screen in turtle units (Clements and Battista, 1990) to determining the creation and placement of shapes for "original art designs." The Montevallo approach includes the creation of an environment supported by the review of research by Allocco et al. (1992) of giving the students choices, creating a helpful environment, turning mistakes into opportunities for exploration and learning, and encouraging cooperative learning. For example, the computer instruction, Individual Art Work (which is available from the authors), is designed as the ninth session in the instructional sequence and includes: topic, objectives, activities, resources, and evaluation (journal questions for the preservice students). This plan illustrates the independence encouraged for the fifth graders after they have been exposed to and experimented with some of the basic commands for eight weeks.

The reinforcement center component of the lesson plan, As the Turtle Turns, which is available from the authors, reveals activities which reinforce and extend concepts presented in the computer lessons. Taylor (1991) confirmed the utilization of this process as a means of assisting students in making connections. The discussion and "processing" of the computer activities provide a reason as well as facilitating mathematical connections between the geometric concepts of Logo and their applications. Care is taken to assist the students in making connections between their Logo activities and the mathematical topics found in the curriculum. This center plan was developed cooperatively with one of the fifth grade teachers to insure direct transfer of skills.

Preservice Reflective Evaluation

The preservice students are guided in their observation and reflective evaluation of the fifth graders' cognitive processing during the instructional period by the provision of "leading questions" in the "Evaluation" section of each plan prior to the fifth graders' class. The questions are provided before the class instruction to focus the observation during the lesson. The questions each week are designed to assist the preservice education students to observe the fifth graders' comprehension, participation, reaction to the technology and lesson content, response to errors, and interaction with the teachers and peers. The students have two days in which to complete their journal entries, which allows time for reflection. When the journals are returned the following class period, the professor highlights in-depth responses for discussion and allows time for oral input and questions about the fifth graders' responses.

Examples of the questions from one lesson are presented below:

Lesson 1: Introduction to LogoWriter: Computer Instruction

Activities include body simulation of turtle moves, introduction of basic move and turn commands, individual exploration of use of commands, and individual creation of a square with large group discussion.

1. Can students boot LogoWriter without difficulty?
2. Can students control the turtle with the stated commands?
3. Can students determine the directions and number of units to create designs?
4. What commands do students utilize when given time to explore?
5. What are students' reactions to the turtle and the lesson?

Lesson 1: Introduction to LogoWriter: Center Instruction

Activities include large group orientation to Logo concept and turtle commands with robot simulation, review of commands with "Concentration" game, keyboard review, and journal entries on previous experiences with computers.

1. Were students able to specify instructions to the "imaginary robot"?
2. How well did the students learn the LogoWriter commands?
3. How did the students respond to the journal writing? What were their initial thoughts about experiences with computers?
4. How did the students respond to the days' activities? Were they active participants?

Review and analysis of the preservice students responses to these "leading questions" reveals that intense observation and reflection are occurring. In response to limited journal entries by her fifth graders, one decided to ask them how they figured things out in their heads. The ensuing discussion lead her to assess that they "understand better if they figure out things physically." During another component of the lesson when the students were having difficulty decoding a Logo message, she described her modification of the plan to assist them. Recognizing their difficulty in making the transfer to the abstract verbal symbols, she used the top of her pen as the turtle so they could visualize the turns. In response to the paper art activity in a center lesson and the design on the computer, one preservice teacher observed some confusion but assessed that both students seemed to be kinesthetic learners who learn better with "hands-on" experiences. One teacher was exuberant in her journal entry after a reluctant fifth grader got up and moved her body by her choice for the first time to figure out the correct Logo commands. Other students observed the manner in which the children approached errors: they were beginning to quickly correct their bugs rather than depending on the teacher to provide the revision. In working with a child who was having difficulty comprehending the connections between a center activity and a computer activity, the student recognized the benefit for the fifth grader to observe that her teacher made mistakes and how she corrected them. The preservice students' reflective evaluations might best be summarized by the entry of one student who observed her children's surprise and delight at their success in identifying and estimating the angles in the Turns lesson. She reflected, "I think this proves the theory that computer programs like Logo can very effectively teach skills while also providing enjoyment to students."

Implications for Technology and Teacher Education

From the literature reviewed and the experiences in the Montevallo initiative, the consensus seems to be that the computer should be used as a "tool" of instruction and that mastery of the computer should be a goal of teacher education. Integration of technology into the curriculum can be accomplished only when the teachers have internalized its use and value. The impact of Logo or any other technological application is determined by free access to the computer and proper teacher intervention. Through collaboration with local schools, universities with strong technology components in their teacher education programs can both provide that access for elementary students and enrich the preparation of preservice teachers.

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Laptops, Portable Computers, Databases, and Possibility Thinking in Preservice Teacher Education

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Students with a varied range of technology skills enter preservice education classes. Some have completed college coursework introducing technology, some work with technology in their employment, some have attended technologically-rich high schools, and some have the personal resources to acquire their own computer technology for use. The majority, however, have not had in-depth exposure or access to technology, have not developed an awareness of the wide possibilities technology has to offer them personally, and have had little hands-on experience with technological tools that are currently available. A goal in teacher education is to advance preservice teachers' knowledge of technology so that they can access technology's power for their own use and can use this knowledge and experience to teach their future students. At the same time, advances in hardware platforms and software programs require faculty to simultaneously develop their own skills in technology while using it in the classroom.

The preservice teachers involved in this activity were enrolled in three sections of the course entitled Methods and Materials for Developmental Reading. Preliminary class discussions indicated a wide range in students' knowledge and personal use of technology for their own purposes. Initial instruction included informal introduction to the use of the on-line library catalog, which modeled the use of a database as a tool. A survey (Appendix A) was used to explored students' background knowledge. Results indicated the students' need for additional opportunities to apply technology skills and to further personalize their use.

In an effort to increase student knowledge, provide direct practice, and increase motivation for technology use, the activity was planned to address several areas: relevant class content, personal value, and future possibilities thinking.

As a part of this particular course, students gather resources to prepare presentations on storytelling as an art and instructional form. Many of the students are commuters and must make efficient use of resources during their time on campus. If students were to work collaboratively on creating and establishing a resource database of storytelling sources, several purposes would be served: 1) students would participate in the creation of a tool to serve their personal needs; 2) students would have access to many more stories and guides than they could easily find individually; 3) students would learn the process of creating and using a database with hands-on opportunities for practice and advancement of their skills in using technology; and 4) the process would model possibility thinking for the students.

Their classroom resembled many typical college classrooms in that it did not contain a computer for their immediate use. Temporary use of a portable computer or laptop made it possible to bring the technology to the students conveniently and encouraged thoughtful discussion of visions of future use in their own classrooms. Students could see that teachers in a room devoid of computers would not be limited by a lack of immediate access. We could arrange for the technology to come to them, just as

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they could arrange for technology to come to their students in the future.

Setting Goals

Goals for the reading class and for technology skill advancement needed to be examined and set prior to initiating the activity. The additional technology skills content needed to complement but not supplant content related to previously established course objectives. As a part of this course, students study the value, art, and advantages of storytelling for their own use and to teach to others. This content would be enhanced by the use of a database to consolidate resources.

The technology skill goal was to increase background experience with databases and computer use. This knowledge will increase the likelihood of greater awareness of and sensitivity to computer and database use in everyday activities.

The goals for course content were coordinated with the goals for increasing technology skills by having students plan a creative, collaborative design of a database for resources being acquired for storytelling reference. The same database will serve as a useful base for the next university class to expand.

Background Survey Indications

A survey was administered to determine prior experience with databases and with laptop portable computers.

Three preservice classes (97 students) participated in the survey. (See Appendix A for a condensed list of questions asked.) Sophomores through post-graduates were enrolled. Ages ranged from 18-44.

Platform Used. Only 4% of the class considered themselves non-computer users; 35% reported that they could use more than one platform.

Computer Classes. Most students had taken at least one course as an introduction to computer use. Successful completion of the computer course is a prerequisite of the education program. A few students had taken this course at a different institution. Some students reported additional high-school courses in computers. One student reported a class taken in junior high. Others had completed computer classes at work or in other environments.

Where Computer is Used. 45% of the students use computers at home; 33% at home; and 18% at work.

Software Used. When asked which software they used, students in the three classes named 37 different software packages. 80 students reported having created a spreadsheet, yet only 34 reported having created a database. In fact, 26 % of the students reported not knowing what a database was, even though for class students had used databases in the library and undoubtedly many had used databases in other environments. Although databases are usually covered in the introductory computer courses, the results of this survey suggest that transfer of this knowledge to current course content is incomplete.

Materials Preparation

The original intent was to use a laptop (Macintosh Powerbook 180) in the classroom to accomplish the goal. This would have been possible through the use of lecture and overheads describing the process, followed by hands-on experience. Because of the size of the computer screen, only a few could view the process at a time. A better method was selected for the classroom presentation using a rolling cart containing a computer, an overhead projector and an LCD (liquid crystal display) projection panel. This additional equipment allowed the actual process of creating the database to occur in full view of the whole class.

Having chosen this method of presentation, several logistical challenges needed to be resolved:

1. Use of the portable hardware needed to be coordinated with other faculty members working on additional technology projects in other locations.
2. Faculty training was necessary to practice use of the hardware. Operations specific to use of the laptop model and the portable computer with display device were necessary to learn. 3. Training was also necessary for ClarisWorks, the database software program that was chosen for its ease of use and its great likelihood of being encountered in the elementary schools in the immediate area.

Faculty members skilled in the use of the particular hardware and software assisted novice faculty members Individual one-on-one training and access to training manuals developed by faculty was provided. This training was necessary even though faculty members were "computer literate;" the new hardware and the new software program required additional literacy skills beyond beginning levels.

Faculty discussed fields that might be included in the database, but it was decided to allow students to create the list of fields for the database themselves. By allowing trial and error, greater student involvement was anticipated with the possibility of greater transfer and ownership of the process. After initial development, classes could compare and contrast their database with the databases created by other classes for reflective improvement.

Classroom Application

To introduce the topic, classroom lecture and discussion covered characteristics of databases and examples of databases in daily activities. The purpose of the activity was explained and students interacted to create the database, choosing fields to include.

In the first class presentation, a skilled (expert) faculty member assisted another faculty member and class in the creation of a database for storytelling resources. This assistance provided technical modeling of critical skills. The extra assistance was especially helpful because of the expert faculty member's speed and comfort with using the technology and extra ability in creating an artistic "layout" or arrangement of the database fields. By co-teaching the lesson, the faculty modeled the benefits of collaborative effort and participation on the part of faculty.

Two additional classes created fields for establishing their databases. After creation of the databases, students entered their information into the fields on an individual basis.

Students in the three classes then compared the databases created by the others and made suggestions for a new composite database form to be used in future classes.

Student information was consolidated and printed to hard copy. For those students owning the same software package, a copy of the database was provided on diskette.

Discussion

Through the activity, several goals were achieved: students created a resource of value to themselves and to others; students observed the potential of using a laptop or a computer on a rolling cart with a display unit in the classroom; and students received hands-on experience with a laptop or portable computer.

Providing time for the individual hands-on experience was not a simple matter. Continued access to the portable technology required coordination. Use of building computer labs required some amount of supervision also. General use of the lab required explanation. The actual hands-on entering of information required continuous assistance also. The particular software program did not allow simultaneous access on the network for multiple users. These are difficulties that will be eased as each student and faculty member becomes more familiar with more hardware, software, and systems requirements. At this stage, the hands-on experience for nearly 100 students required an extended time period to accomplish.

After the activity of designing a database, students showed increased awareness of database characteristics and potential. Follow-up survey reports showed a significant increase in the number of ideas students could generate on potential portable computer use in the classroom. Greater awareness of the possibilities should lead to further investigation and computer use.

An important aspect in the success of this activity was the interaction among faculty members in the contribution of their special talents. As new technology becomes available, additional training with new equipment and new software packages is important, even for faculty that may be computer literate. The modeling of collaborative exchanges between faculty members and continued technology skill learning is important. The content and processes of technology skill and the content and process of collaboration are reflected in student responses. Skilled faculty's willingness to share their time and talents to advance the skills of their colleagues cannot be underestimated in importance.

Summary

Increasing preservice teachers' skills in technology use can be challenging. There are many expectations for traditional content and strategies already in place with the additional need to add content and strategies for technology use. Advances in hardware and software require continuous training - which takes time. Careful consideration must be given to how to coordinate and blend traditional course content and time requirements with expectations for additional technological skill. Because of the wide variety in student and faculty background and the variety in hardware platforms and software programs, students and faculty must continually and simultaneously be developing skills in breadth and depth. The ongoing changes brought about by new releases necessitate continuous updating of skills. Collaboration among faculty and students will be critical in facilitating this ongoing training need. The modeling of sharing expertise and sharing common products is important and has an effect on students.

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Appendix A

Background Student Survey Questions

Name
Classification
Course
Age
Each computer course taken: (title, where, when)
Which computers do you use? (type, software, purpose)
Location (school, business, own, other)
Have you ever used a database? If yes, what was it?
Have you ever created a database for your use? (If yes, what was it?)
Have you ever created a spreadsheet?
Have you ever seen a laptop being used? (If yes, for what?)
Have you ever used a laptop computer? (If yes, where and for what purpose?)
If yes, how many minutes or hours would you estimate you've had hands-on experience on a laptop?
What would you do with a laptop if you owned one?
What would you do with a laptop in your future classroom, if your school checked one out to you?

Customizing Technology in the Classroom for Preservice Educators

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Although computer-assisted instruction (CAI) has been around for more than a decade, application of computer technology in the school remains a problem. Many studies (Wetzel 1992; ISTE, 1992; Electronic Learning, 1991) indicate that most education graduates today do not feel comfortable about teaching with computers or technology. The issue of what they have learned versus what they should learn must be reexamined.

Technology instruction for preservice teachers should be based on their future job needs as well as the current technological reality in the school. Teaching preservice educators to use the computer technologies that are either different from or not available in today's school settings is impractical. What the preservice teachers need to learn about computers and applications should be different from a general computer literacy program. Currently, the majority of computer instruction given to preservice teachers is in two areas: using computers as tools (word processing, spreadsheet, database, graphics, and communications) and developing multimedia-based applications. Such instruction is important to enhance computer literacy and keep the preservice teachers current; however, the preservice teachers should learn not only about the knowledge and skills to use computers and application programs but also about how to customize available software programs and hardware to suit various instructional situations.

Also, applying computer knowledge and skills to teach content areas across curricula is a highly desirable objective. Today's teachers are facing the obstacles of inadequate resources, lack of technical support, and insufficient time, which make this objective difficult to accomplish (OERI, 1989). Customizing technology will help preservice teachers tackle some inevitable obstacles and focus on what can be done with limited resources. To integrate customized technology into teaching will also empower preservice teachers to increase the efficiency and effectiveness for teaching and learning performance.

Facing The Reality

Two types of technologies are available to today's educators: limited or outdated computer technology versus fancy multimedia-based computer systems with all the power-enriched peripherals. Many preservice students have been exposed to the use of exciting hypermedia and multimedia from the computer application courses they have taken. Later, when they were employed as school teachers, a number of them became star teachers for what they knew and could do with the newest technology, while most others could not even get a decent computer that allowed them to run recent word processing programs. Some of them were lucky enough to get a few computer systems with limited capability and insufficient quantity. Suddenly, they become frustrated because there is not much they could apply from what they were taught to this meager reality.

The current status of computer instruction in the schools does not look promising and can often be described as in the following conditions: 1) preservice and practicing teachers are not prepared to use technology in instruction; 2) today's schools cannot keep up with the development of technology; 3) most of the currently available software programs still do not provide quality to meet specific instructional needs for various grade levels and content areas.

Integrating technology into curricula poses a serious challenge to preservice teachers. Resta (1993) pointed out that most preservice teachers are limited to a single required "computer literacy" course, taught by a technology-oriented instructor in a computer lab. In this way, preservice teachers are provided with limited and isolated experiences with technology. Such a course often fails to show technology as a tool for integral learning and personal productivity that can be used across academic disciplines, methods courses, and clinical experiences. Wetzel (1993) suggested that many teacher education faculty lack both the technical knowledge as well as the knowledge of how to use computers in instruction. Resta (1993) also stated that most teacher education faculty members do not have incentives to integrate technology into the preservice curriculum because they find it under-valued to infuse technologies into courses compared with other duties such as teaching, advising, research, and services.

Although more equipment is available now than before, computer resources and equipment in the schools are still somewhat limited. Adams (1989) commented that shaky software and too few machines raise the question whether computers in the schools are worth the bother. There have been many reports about the status of computer use in the school. For example, the Arizona Department of Education (1992) recently detailed the types of computers used in the schools. Most machines (microcomputers) used in the schools are old, simple, and have very limited capabilities (such as old Apple IIs, IBMs, or Macintoshes).

Also, schools seemed to be much slower in catching up with new technology than the business world. Teachers often lack the training, resources, time, and administrative support to effectively implement technology in instruction. Facing funding shortage, most schools today are having difficulty in supporting technology for teachers. Kinnaman (1993) presented several common examples of the budgetary problems with school technology improvement, such as incredibly limited amount, and stiff and restricted budgetary policy which makes funds non-transferable to purchase the truly needed items.

On the other hand, even if the teachers were financially supported to use technology in the classroom, they might not be able to find many good quality programs that they could use for specific instruction for certain grade levels and content areas. Bonner (1992), having reviewed over 5,000 commercial PC software application programs, estimated that between 90 and 95 percent of the programs would prove to be failures because they were not designed specifically with educational users in mind.

Based on these facts, we are facing a very tough challenge for integrating computer technology into the schools. It is especially discouraging for preservice teachers to face their future careers if what they are learning in college does not prepare them to work in the future.

What is meant by Technology Customization?

There are often many alternatives one can take to get a job done. As our skills improve, we can always find a better strategy to make decisions about how to maximize our performance. This is also true when utilizing or customizing technology applications.

Customizing technology for instruction can be done in several ways: 1) to use the software or hardware in our own way to best increase effectiveness and efficiency for personal or professional productivity; 2) to adjust the available but incompatible electronic resources to make them work to our needs; or 3) to curtail and to apply available electronic resources to teach content areas across curricula. For teachers, to customize technology really means to use software, not only as it is, but in the ways teachers need and prefer. They should not be restricted to the limitation or inadequacy of the technology.

Some Examples of Customization

There are countless examples of successful technology customization for personal productivity and professional performances in the school. Here are a few instances.

A typical example of customizing technology is the menu system. The teacher can create a customized menu using DOS batch commands or shell program for students to select a particular program. In such a way, choosing the program item will be quicker and easier with a great reduction in confusion for students.

Very often, installing software programs will require users to provide information about the hardware and software configurations such as mouse devices, video capabilities, and memory. A teacher can modify the program configuration to run the program on limited hardware. For instance, many powerful programs, such as WordPerfect or IBM LinkWay, will preferably require large memory and much disk space. However, after modification of the system configuration, these programs can run on the two-floppy systems which are often available in the schools.

To enhance the use of computer hardware for instruction, there are many possibilities that a teacher can have to optimize their productivity and performance. They can invest in an inexpensive modem to dial up a local bulletin board system or to connect to telecommunication groups to acquire tremendous useful resources such as good educational shareware programs. They can use LCD panels with their computers for in class demonstration and discussion. They can also connect many low-end computers and set up a network for optimal use.

The teacher can also convert application programs into tools for specific purposes. Using word processors, with the spell-checking and word-counting functions, a teacher can develop a typing test tool. With features such as outlining and line numbering, word processors can be used as an idea-generation tool. The teacher can customize a spreadsheet program using the formula and calculation features to develop a grade book. Graphics programs can be used to develop a personalized story book. To develop problem-solving and thinking instruments, a teacher can use various application programs such as database or spreadsheet programs. Database or graphing programs can be used to enhance students' personal connections to data relevant to their lives.

Sometimes, teachers will find the courseware programs inadequately developed for the subject. They have to be selective. They can, for instance, use part of an atlas or map program to teach geography with guided questions. Such types of examples exist in many reports. Simon (1993) describes how the classroom teacher can relate history to students' own lives and experiences using several computer programs to reinforce students' learning. With some instruction, preservice teachers can learn how to turn data into information and change resources into useful instructional and communication media. Teachers will become flexible and creative in using computers to optimize their productivity.

The Need of Technology Customization in the School

Technology customization becomes indispensable when the available technology is not set up properly to maximize personal productivity or professional performances due to technological limitations. In a school setting, many situations could require teachers to customize technology to maximize its use.

Teachers do not need to know or use everything about computers before they can take advantage of the technology. However, mostly, teachers cannot find adequate software programs for their personal use or for instruction. Also, a frequent problem that teachers encounter when instructing with computers is that they do not have appropriate equipment — the machines and the programs are obsolete; the contents of the programs do not fit the desired teaching setting; and the hardware and software are incompatible. One concern most teachers have is how to patch up the inadequacy of their equipment. Another concern is how to find and use relevant resources effectively in instruction. If these problems are not solved, teaching with technology in the school will continue to remain a problem.

Analogy of Using Old Technology in the School

I have seen an extremist position develop about what we need to have in the school. One group of scholars radically advocate that the schools' computer systems are outdated and we should get rid of them. However, the existing equipment may be less sophisticated than the new technology but will not disappear immediately. Our schools simply cannot afford to replace all the existing resources with new ones at once. We should learn to live with what exists and make the most out of whatever is available to us in the schools. Also, the following questions should be asked to address this concern:

- Can our students and teachers still benefit from the existing equipment in the school?
- How much more will our school personnel benefit if we discard most or all of the existing equipment and get a few pieces of new equipment?
- How may we benefit from using the existing hardware and software?

We often need some basic skills to carry out the intended tasks no matter what tools and methods we are going to use. Take driving as an example. Before we can afford to drive a brand new BMW or a Mercedes, driving a used second-hand car will also serve the purpose. Besides, driving from home to work every day, we do not absolutely need a BMW to do it.

I am not suggesting we should not use the high-end machine. What I'm saying is if we cannot afford the high-ends and, in the mean time, the low-ends are still meeting the needs and serving the purpose, why should we discard all the low-ends? High-end machines can make fancy things possible and attain higher performance but the low-end machines will allow us to complete the minimally required tasks and develop basic computer literacy and the skills needed to operate computers.

To own the high-end equipment does not necessarily mean we are technologically advanced. If we are requesting the high-end machines only for the purpose of completing the minimally required tasks such as basic typing and word processing, we are wasting the technology. With high-end machines, we need to conduct business to maximize the high-end vision. For example, many new software programs that make extensive use of sound and enhanced graphics are probably more necessary for teaching young children.

The key issue we need to address is how to make the most of the available resources no matter what we have available.

How to Teach the Preservice Educators to Customize Technology in the Classroom

Preservice teachers should be taught to be aware of the following aspects so that they will be knowledgeable and capable to optimize their performance in their future computer using environments.

1. They should learn to operate a computer and use software successfully.
2. They should familiarize themselves with the available programs and machines in the schools.
3. They should be able to use application programs (e.g., word processing, spreadsheet, database, graphics, etc.), courseware programs (e.g., tutorial, drill & practice, simulations, education games), and multimedia or hypermedia-enriched instruction programs. They should also be aware of the basic system requirements for these programs.
4. They need to know how to use computers for many things such as to manage responsibilities (e.g., test

making, grading, and other paper work), to make presentations, to lead discussions, and to inspire enlightening self-discovery or problem-solving.

5. They should be able to increase productivity with meager resources and limited computer capability through the following actions:
    a) Upgrade old equipment with extra hard disk space, memory, and other devices, as needed.
    b) Make use of a single computer for classroom demonstration, or cooperative learning activities as Dockterman (1991) suggested.
    c) Put computers together to setup and use networks.
    d) Use modems to connect available to bulletin board systems (BBSs) or other telecommunication groups or resources.
    e) Increase the availability of resources by searching for public domain & shareware programs.
6. They need to be able to evaluate both software and hardware for strengths and weaknesses and requirements for educational application (such as grade levels, content areas, etc.)
7. They should be able to plan effective lessons using existing computer technology. They should also know about how to combine teaching and learning theories with the use of technology in instruction.
8. They should be able to identify and evaluate available computer resources for their needs.

To employ technology effectively in teaching requires making an effort to use technology, to customize existing resources, and to be creative. Many ideas for projects should be collected and introduced to preservice teachers to show them what is available and what is possible.

Conclusion

Many people have confidence in the ability of computer technology to enhance classroom instruction. Despite the harsh facts of the current use of computers in the school, one of the most important things we should teach the preservice teacher is to adapt the teaching environment to take full advantage of whatever computer technology is available to them.

Customizing technology demands a higher level of knowledge and skill than the regular basic computer tasks. It requires not only mechanical knowledge of using computers but also a creative mind to implement available resources for better performance. Customization might take more time for the preservice educators to master but it will prove useful and practical once they begin to integrate technology into instruction. Our computer skills and knowledge grow with the amount of time and effort we put in, and so does our ability to customize technology for teaching. As Altman (1993) put, "We do believe that there is a philosophy associated with using PageMaker (a software program). But you cannot practice instinct and you cannot learn feelings; they must come to you over time (p. 40)." Customizing technology for instruction will some day be carried out by teachers instinctively.

In summary, customizing technologies will help the future teachers know what computer technologies are available to them and understand the reality in the school. Thus, they will make themselves flexible to use and take advantage of whatever is available to them. They will build confidence to survive in the technological environment because they have learned the basic skills to use computer application programs as well as strategies to deal with limited resources. They will also know how to enrich the quality of teaching through the integration of technology in instruction as feasible.

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Alternative Models for Evaluating Technology-Enriched Professional Development Schools

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There are several areas in the study of technology and teacher education that hold promise for improving the education of preservice and inservice teachers. One area that is currently receiving a great deal of attention is the use of technology-enriched professional development schools. Professional development schools (PDSs) have been found to be effective sites for improving: (a) the staff development for inservice teachers and (b) the preparation of preservice teachers (Diem, 1993; Goodlad, 1990; Stallings & Kowalski, 1990). These PDSs are typically sites where classroom teachers are considered to be master teachers so that they can demonstrate exemplary instruction to preservice teachers as well as be involved in their professional development.

Some of these innovative schools are now becoming "technology enriched." These technology-enriched schools and classrooms contain "state-of-the-art" technology and usually include computer networking among preservice teachers, classroom teachers, and university personnel. These schools have the potential to change existing teacher education programs because the programs will become much more experiential and school-based and will also allow teachers, preservice teachers, administrators, and university personnel to interact through sophisticated computer networks (Bright & Waxman, 1993). Technology-enriched PDSs can change teacher education programs by: (a) restructuring the traditional instructional approaches in teacher education programs, (b) helping preservice and inservice teachers learn the skills necessary to teach using technology, and (c) helping university faculty learn how to use technology in their own teaching. Research and evaluation on the effects of these types of new schools and programs are critical, however, in order for us to document the impact that these professional development and technology schools have on improving teacher education and teaching and learning in schools.

Recently, there have been several articles that have described technology-enriched professional development schools or professional development and technology schools (Diem, 1993; Doornekamp & Carleer, 1993; Grandgenett & Mortenson, 1993; Lasley, Matczynski, & Williams, 1992). Yet there have been very few published studies, reports, or articles that have examined the effectiveness of these schools. There may be several reasons why there has been very little research and evaluation of these projects. First of all, in such collaborative projects, research and evaluation may be seen as counter-productive to working relationships between the school and university (Collis & Carleer, 1993). Second, even if there has been some type of research or evaluation conducted on the project, these reports have not been effectively communicated or disseminated. Finally, Collis and Carleer (1993) describe some of the problems that educators have finding appropriate theoretical and methodological approaches for examining technology-enriched projects. Since many professional development and technology schools are currently being established across the world, it is important to clarify some of the critical issues and assumptions associated with the evaluations of those schools. The purpose of this article is to describe several alternative models or approaches that can be used to examine the effectiveness of professional development and technology schools.

Examining alternative models of evaluation for PDSs is important because in educational research and evaluation, the answers or conclusion we obtain are determined by the: (a) type of questions we ask, and (b) methods we use to resolve them. Unfortunately, investigators' personal commitments to a given evaluation model or research methodology have sometimes guided and shaped the research process by affecting their choice of design, instrumentation, and interpretation of data (Dunkin & Biddle, 1974). In other words, the selection of the evaluation model is often related to the theoretical or ideological commitments or beliefs of the investigator Awareness of a variety of evaluation models or approaches can broaden our perspectives about research problems and change our ways of thinking about what we can study and how we can study it (Kerlinger, 1977). The following sections describe several alternative models that can be used to examine the effectiveness of PDSs. The key assumptions and methodology will be discussed for each of the evaluation models, as well as the strengths and weaknesses.

While the conceptual work on models of evaluation by House (1980), Madeaus, Scriven, and Stufflebeam (1983), Stufflebeam and Webster (1980), and Worthen and Sanders (1987) is an important starting point for examining alternative models of evaluation, the more recent work on evaluation in instructional technology (Kifer, 1991), and research paradigms in instructional technology (Driscoll, 1991) and technology and teacher education (Waxman & Bright, 1993), is more appropriate for examining technology-enriched PDSs. These alternative models or perspectives of research and evaluation encompass the most recent and comprehensive theoretical perspectives of the field of technology and teacher education. Therefore, the evaluation approaches described in the present article follow the perspectives of the paradigm and evaluation models in instructional technology more than the generic evaluation models. For each of the models described in the following sections, some of the key questions that each approach addresses will be discussed, as well as the strengths and weaknesses of each model for evaluating professional development and technology schools.

Alternative Models of Evaluation

Program evaluation focuses on the systematic collection of data about a program in order to make a value judgment or decision about it (Alkin & House, 1992). Program evaluation differs from educational research in that evaluation is more concerned about providing information for decision-making purposes for a specific context, while educational research typically operates from a theoretical framework and focuses on the generalizability of results. Given that most PDSs typically exist in a particular school where: (a) data collection will most likely be dictated by feasibility, (b) control of the relevant variables will be low, and (c) generalizability of the results will be low, it appears that program evaluation is more appropriate than educational research for addressing issues of effectiveness.

As previously mentioned, many researchers and evaluators have developed frameworks or typologies for categorizing evaluation approaches or models. These categorizations or conceptualizations are often helpful in that they enable educators to examine the similarities and differences among paradigms or approaches.

Classroom Observational Model

The observational model focuses on the observed classroom processes and behaviors of students and teachers in technology-enriched PDSs. This model investigates how classroom instruction and student behavior changes as a result of the PDS or is influence by the PDS. Some of the advantages of this approach is that it typically uses low-inference, observational instruments that provide reliable and valid measures of classroom processes and interactions among students and teachers. Some of the weaknesses of this approach are that it is very costly in terms of time and money to collect observational data and this method focuses on observed classroom behaviors without usually addressing the intent of the behavior. Some typical questions that this evaluation model would address are: (a) How have teacher and student behaviors changed as a result of the implementation of technology, (b) To what extent has technology been integrated into the existing curriculum, and (c) To what extent are students engaged in their academic work when using and not using technology?

Connoisseurship/Criticism Model

Connoisseurship is the art of appreciation and it consists of recognizing and appreciating the qualities of a particular phenomena. Criticism is the art of disclosure and it composed of three major dimensions: (1) descriptive—identifying and characterizing, (2) interpretive—indicating what the situation means to those involved, and (3) evaluative—appraising the value. One of the advantages of this model is that it is comprehensive, incorporating all aspects of the project. The vivid descriptions that one obtains from the criticism or evaluation report are often very meaningful to the participants involved in the study. The key limitations are that this approach is extremely subjective and it is totally dependent upon the skills and background of the evaluator or connoisseur. Some of the typical research questions that this evaluation model would address include: (a) What are the key characteristics of the PDS, (b) How do students, teachers, and university faculty interpret the collaboration, and (c) What is the overall effectiveness of the project?

Ethnography or Case Study Model

This model discloses the "way of life" for all the participants of the PDS. Some of the advantages of this approach is that it includes the perspectives of teachers, students, parents, administrators, and university personnel in its evaluation of the project. It may also involve school district administrators, state-level administrators, and university administrators. One of the key limitations is that it is a relatively subjective approach, again dependent somewhat on the skill of the evaluator who often becomes a participant in the process. Some of the typical questions that this evaluation model would address are: (a) What are classroom teachers' and university professors' expectations about the PDS, (b) How do students, parents, and administrators feel about the PDS, (c) How successful are teachers in implementing the technology in their classes, and (d) What difficulties do classroom teachers and preservice teachers have in working in the PDS?

Experimental Model

This model investigates whether or not there is a statistically significant difference between the technology-enriched PDS and a control school on some dependent variables such as students' or teachers' cognitive, affective, or behavioral outcomes. One of the advantages of this model is that it can make a causal inference relating the effects of the PDS to some specified outcome variables. One of the key disadvantages of this model is that it is often very difficult to conduct "true" experiments in the field because of the problems associated with randomly selecting which schools should become PDSs and which ones shouldn't. There are also many other sources of invalidity that need to be addressed in experimental studies. Some of the typical questions that this evaluation model would address are: Are there significant differences between the PDSs and control schools on (a) students' academic achievement, (b) teachers' classroom instruction, (c) preservice teachers' attitudes toward the teaching profession, and (d) teachers' implementation of technology?

Student Cognition Model

This model focuses on students' responses and psychological processes that govern learning. This approach examines how students interpret and understand classroom reality. It also investigates how students approach, think about, and learn specific tasks. Some of the advantages of this model are that it emphasizes the importance of students' thought processes and cognitive learning strategies. It highlights the learning processes that students use when they comprehend text, solve a problem, or approach any learning task. Some disadvantages of this approach are that it focuses almost exclusively on students and that it is very time consuming to assess students' cognitive learning strategies. Some of the typical questions that this evaluation model addresses are: (a) What are the cognitive learning strategies that students use when working with technology, (b) How are these processes different when they work with technology, and (c) Are there differences between high-achieving and low-achieving students on their cognitive learning strategies?

Teacher Cognition/Clinical Information Processing Model

This model focuses the thoughts and motives of classroom teachers. This approach assumes teachers are goal-seeking problem solvers whose ability to deal rationally with their environment is constrained by their limitations to process information. Some of the advantages of this model are that it emphasizes the importance of teachers' intentions in the instructional process and it examines the factors that can hinder the implementation of technology in the curriculum. A disadvantage of this approach is that it often requires that the teacher and evaluator spend a great deal of time reviewing lessons or watching videotapes of lessons. Some of the typical questions that this evaluation model addresses are: (a) What are the factors that prevent teachers from integrating technology in their classroom instruction, (b) What are teachers' attitudes toward technology and being involved in the PDS, and (c) To what extent do "expert" teachers implement technology differently from "novices?"

Discussion

One of the most serious problems related to school-based technology programs is that there has been a proliferation of such programs before adequate research and evaluation has been undertaken to examine their effectiveness. There are serious questions, for example, about two of the most widely disseminated programs, Apple Classrooms of Tomorrow (Ross, Smith, & Morrison, 1991) and IBM's Writing to Read (Slavin, 1991). Before technology-enriched PDSs become widely implemented across the country, there should be systematic evaluations of such projects. In addition, these evaluation reports need to be widely disseminated so that their findings can be used to guide and improve practice.

There have been many general criticisms related to the poor quality and quantity of research in the field of educational technology (Brooks & Kopp, 1989; Clark, 1989; Gentry & Csete, 1991; Hannafin, 1985; Hannafin & Hannafin, 1991; Maddux, 1993). In fact, there has been so relatively little research in the field of technology and teacher education that some critics are urging teacher educators to assume their professional responsibility and begin to systematically evaluate the impact of technology in teacher education programs (Brooks & Kopp, 1989). The lack of systematic research and evaluation on the impact of technology on teacher training may become one of the major factors that may hinder the progress of technology-enriched PDSs.

Due to the current criticisms of research in technology and teacher education, educators must concern themselves with producing more and better research in this area. The most effective programs of educational research reflect the intelligent deployment of a diversity of research paradigms applied to their appropriate research questions. The use of alternative evaluation models may enable us to extend our understanding of several aspects of technology-enriched PDSs which could then be incorporated in programs to monitor and improve policies, practices, and their effects. Improving the research and evaluation on technology-enriched PDSs, however, will take more than just awareness of the problems and knowledge of some solutions. We will also need a commitment towards quality research and evaluation from both school-based and university educators. A broad, interdisciplinary research agenda will need to be collaboratively developed and then carried out vigorously.

Policy makers will similarly need to acknowledge the significant contribution that research and evaluation should have in formulating policies and suggesting improvements for technology-enriched PDSs.

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Enhancing the Integration of Technology in Preservice Teacher Education Through Building a Technology Classroom

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The University of New England is a small, private, four year institution with professional programs in osteopathic medicine, allied health, teacher education, and social work. Capitalizing on the momentum that surrounded the building of a technology classroom, teacher education faculty have outlined a model for expanding the integration of technology in preservice courses that includes establishing a technology partnership with area schools. The process of acquiring and building the classroom is described and a model for faculty development in instructional technology is suggested.

Modeling the uses of technology in teaching and learning through integration has become a major program goal in teacher education at the University of New England (UNE). The stand-alone computer applications course typically required of preservice teachers prepares them for word processing, database, spreadsheets, and affords some familiarity with education software (Byrum and Cashman, 1993). This approach falls short in that it does not provide preservice teachers with the knowledge, skills, or attitudes needed to use technology as an interactive teaching tool to improve instruction and enhance learning.

The limited use of computers in instruction has been traced to several factors, the most constraining of which are lack of equipment, lack of training and skills, and lack of quality software (Zambo, 1992; Knupfer, 1988). If the program goal to integrate technology in course offerings in the preservice program is to be realized, then these inhibiting factors must be eliminated. In order to accomplish this, faculty in teacher education at UNE have formed a collaborative relationship with faculty from other departments at the institution to develop short and long range plans for the acquisition of technology classrooms with desired software and support for ongoing faculty development.

This partnership has led to many significant outcomes. Of particular importance are the building of a technology enhanced classroom, a new approach to faculty development at UNE, and the development of a model for integrating technology in the preservice program beginning with the first semester of year one and carrying through to the internship experience in the final semester of the program.

Planning a Technology-nhanced Classroom

Partnering with faculty in the Department of Occupational Therapy and the College of Osteopathic Medicine who had developed tutorials for students in kinesiology and anatomy, education faculty explored ways to further incorporate computers in the educational process. Discussions quickly focused on the lack of space and equipment necessary to make the shift toward meaningful integration of technology in the curriculum and in teaching. Concurrently, students in the College of Arts and Sciences were becoming increasingly vocal about limited access to computers.

Faculty approached the Dean of the College of Arts and Sciences with these concerns. The Dean responded with both a charge and commitment to the partnership group.

The charge was to begin developing a technology-enhanced classroom. The Dean committed to obtaining funds for the actual construction.

In meeting its charge, the group engaged in two tasks: 1) learning about technology-enhanced classrooms, 2) conducting a survey of all university faculty to determine needs and requests. Literature review, requests on national bulletin boards and interviews with computer personnel at nearby institutions provided little assistance related to classroom design. The group developed a model which allowed classroom activities to drive design. The second task for the group was to design and conduct a survey that asked respondents to identify the ways in which they currently use technology in their instruction, how they would like to use technology, and what they would need to be able to achieve this. Using suggestions from an Apple Computer publication (Collins, Wing and Teichert, 1991), eleven individuals were identified from the pool of respondents as demonstrating specific needs and/or plans to use technology in their teaching. The planning group expanded to include these faculty members and became the Technology Classroom Planning Committee (TCPC).

In May of 1993, only three months after committing to seek funding, the Dean received approval of a budget for the classroom. Immediately following this, a consultant experienced in the design of technology enhanced classrooms was retained to assist the group. The TCPC met under the following constraints:

- total budget to include furniture, renovations, and equipment could not exceed $90,000;
- the classroom would contain 20 computers with seating for 30 students;
- the room must be "on-line" by the beginning of classes in September 1993.

Owing to the lateness of the academic year, the TCPC was able to meet only once. In preparation for that meeting, each member reviewed literature related to the use of technology in teaching in their specific domain of instruction. The consultant convened the meeting with members prepared to define the learning experiences they wanted to provide in the classroom. Once these experiences were clearly outlined, software and hardware were identified. Because the classroom represents a sizable project for a small institution, the group felt that its success was paramount. Although proponents of both the Macintosh (Mac) and MS-DOS (DOS) environment were equally represented within the group, it was agreed that the DOS users were the best prepared to fully use technology in their teaching in the Fall of 1993. Therefore, the planning committee decided that the classroom should be equipped with DOS machines provided that a second smaller classroom space of 10 Macintosh computers be established. Macintosh users would spend this first year defining how they would use a full-size classroom.

Design and Use of a Technology-enhanced Classroom

With activities, software and hardware defined, the group addressed classroom design. The desire was for a physical arrangement that would promote collaboration among students while not precluding the lecture format. Group members envisioned three possible configurations: tables in rows, a shallow "U" configuration and, finally, arranging workstations around the perimeter of the room. The room designated as the new classroom space is 19 feet wide by 38 feet long.

The committee first looked at the traditional "row" arrangement of tables. To allow eye contact between users and instructor, this design encourages the placement of a computer (CPU) and monitor in a recessed table. Frequently advertised as being "ergonomically correct", this arrangement may in fact lead to increased fatigue and discomfort in users (Collins, Brown, Bowman, and Carkeet, 1990). The two remaining configurations were evaluated by physically taping out 24 x 40 inch footprints in the classroom. Doing so proved that it was impossible to fit twenty worksites into the available space within the "U" shape. The perimeter arrangement allowed for eighteen workstations at the forty inch width plus two additional stations capable of accommodating manual and power wheelchairs (Morrissey,1993). The committee decided that the perimeter layout would best address space issues and would allow for a variety of approaches to teaching. All stations have keyboards arranged to allow easy conversion to left handed mouse use. The instructor station extends a short distance into the center of the room to all liquid crystal display (LCD) projection panels. Three locking cabinets are provided for securing equipment.

A recent, informal survey of students to determine their response to the new classroom was overwhelmingly positive. A number of space related problems have been identified, however. The classroom is situated in the oldest building on campus and ventilation is very poor. The planning team had anticipated possible problems with temperature due to the heat released by twenty computers as well as body heat from students. This has indeed proven to be troublesome. Current plans are to upgrade the air flow in the classroom at the same time that general building renovations are undertaken in 1994.

A second problem stems from the size of the LCD's projected image. Originally, plans called for projecting the instructor's display across the smallest dimension of the room. During construction and after the screen had been ordered, it was decided to project the image along the longest dimension of the room. This resulted in an image too large to be completely projected. Therefore, it was necessary to purchase a higher priced LCD projector with a zoom lens.

A final problem that has arisen has involves the lighting. The planning team had requested that the room lighting be reconfigured into zones. As it turned out, the final wiring only allows three options: full lighting, half lighting, or full darkness. To counter this, physical plant will remove half of the lights closest to the projection screen. This will allow that end of the room to be dark for viewing when half of the room lights are on.

The classroom is in use five days per week beginning at eight in the morning until six at night and at least two weeknights. Some Saturday programs have been scheduled. Education students meet in the classroom for two and one half hours each week for a course entitled *Computer Applications in the Classroom.*

The new Macintosh lab is proposed for Fall 1994. With faculty interest growing, it has become apparent that the one technology classroom is not sufficient to meet needs. The physical layout of the new lab space will be consistent with the perimeter configuration used in the DOS classroom. Open blocks of time will be scheduled so that instructors can use the lab as needed. Preservice students will meet primarily in the Mac lab since this is the platform most frequently found in K-8 schools. Occasional classes will be scheduled in the DOS classroom in order to familiar students with DOS equipment.

Current state of Technology to Enhance Learning

An aggressive faculty development program will begin in the Spring of 1994. And, as a result of the need for additional teaching space, the committee will focus on acquiring a second technology classroom that features Macintosh computers. Simultaneously, and in concert with the computer committee, the education faculty are defining ways to expand the integration of technology in the preservice program. Since access to technology and software is, in large part, no longer a barrier to using technology in instruction, formulating strategies to educate university faculty about its many benefits is an important next step.

In line with much of what is espoused in teacher education programs, strategies will concentrate on a learner-centered approach. Just as our preservice teachers are encouraged to design authentic learning experiences for children that stem from real life problems, the committee has outlined a program that begins with a general hands-on orientation and expands to support faculty in personalizing the integration of technology in their teaching. After all, "Teachers are the content-area specialists and it is they who best design the implementation of technology in classrooms" (Schlumpf, 1991, p. 81).

Currently, students' first experience with Macintosh computers in the program occurs during their first semester with a required eight hour tutorial. If students are able to demonstrate proficiency, they are exempted from the tutorial. Each of the seven methods courses (Reading, Math, Science, Social Studies, Language Arts, Writing, and Creative Arts), has a technology component. As part of their coursework, students evaluate and review educational software; design lessons, learning centers, and units of study that incorporate technology; and use technology to adapt curriculum to meet individual needs. The use of computers for keeping records and assessment is addressed as well. In the computer applications course, students learn word processing, databases, and spreadsheets.

Future directions

The approach to faculty development that we have outlined takes participants through a series of overlapping phases: familiarization with the technology classroom and current software, partnering with mentors, developing individual projects, becoming mentors, and staying current.

Prior to scheduling orientation sessions designed to familiarize faculty with the technology classroom, a full day of vendor presentations will be offered. Presentations will highlight software available in specific disciplines and suggest ways that technology use could enhance teaching and learning. The primary purpose is to motivate faculty and students about the possibilities that technology affords and to generate interest in the follow up orientation sessions.

Two types of orientations will be offered, one for faculty who identify themselves as novices and one for those who feel comfortable with DOS and Macintosh equipment. In each of the sessions, presentation and direct instruction will be minimal. Building on what was learned in the UNE workshop for area teachers and borrowing from the Teacher Explorer Center model (D'Ignazio, 1991), faculty will be immersed in designing presentations, writing tutorials, and multimedia authoring.

Next, faculty will be paired with mentors who will assist them in designing, implementing, and assessing personal projects. Enlisting sufficient numbers of faculty to serve as mentors is a concern. In an institution where faculty already feel that they are working to capacity, persuading members to take on another commitment is challenging. In this first year, though, the level of interest and excitement for bringing teaching at the institution into the 21st century is impressively high and a list of mentor volunteers is growing steadily.

Supporting faculty as they personalize their learning is an attempt to keep our faculty development program from disappearing into the black hole that has gobbled up so many others. Through individualized projects, faculty have the opportunity to acquire the skills, knowledge, and attitudes necessary to use technology in a way that is meaningful, relevant to their teaching, and specific to their content.

Several projects have already been outlined. Education faculty are planning to videotape learning episodes that demonstrate direct instruction, cooperative learning, and learning through discovery and inquiry in K-8 classrooms. The tapes will then be edited and converted to videodisc and delivered by a *Hypercard* program. Instructors can use the videodisc to engage students in reflectively thinking about the differences in each approach, such as the role of teachers and students, the elements of lessons, the effectiveness of the teaching, and the management of classroom behaviors.

During the time when faculty are working on their projects, participants and their mentors will be brought together on a regular basis to discuss their work, ask questions, and share problems and solutions. As the pool of experienced and knowledgeable faculty members grows, the

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number of individuals capable of becoming mentors increases. These individuals will be encouraged to voluntarily serve as mentors to a new group of novice faculty.

Some of the work of staying current with the advances in technology will be done through the mentoring group and other less formal networks. With the support of the committee for faculty development, an electronic newsletter describing new and future advances in hardware and software will be disseminated to all faculty. Also included will be a description of the projects that are in process, follow-up to previous activities, and announcements of upcoming events. In addition to relying on expertise within the university, outside speakers, consultants, and vendors will be invited to present information.

In its effort to expand the use of technology in delivering the preservice teacher curriculum, education faculty have identified three major points of focus. They are: modeling and engaging students in technology assisted instruction in all of their professional coursework; establishing workshops for area teachers; and placing teacher interns in classrooms where technology is a vital part of every school day.

In the teacher education program, teacher educators strive to model positive and effective teaching behaviors. The current computer applications course with it's "show and tell" approach is a poor model of practice. "Research in human development states that we learn well what we see modeled, and learn better what we can experience" (Kelly, 1990, p. 92). Through the mix of tutorials, a basic introductory course in the role of technology in the classroom, and the integration of computers in professional core courses, students leaving the program will be proficient and enthusiastic users of technology for both teaching and learning. Kay (1990) found that positive cognitive attitudes and skill in using computers and applying software, were significant predictors of preservice teachers use of computers in education.

Added to the technology components already included in the program, students will become knowledgeable users of videotapes and video cameras; videodiscs and players; CD-ROM programs and computer simulations; and Quicktime. Students will use *Powerpoint, Aldus Persuasion* , and *Hypercard* to drive presentations. They will also become familiar with telecommunications via America Online and Internet.

The second area of focus for teacher education will be to form a partnership with a local school system that provides access to technology for its teachers, but finds that instructional technology is underutilized in classrooms. Following the same approach used to assist faculty at the university, teachers will be educated through workshops and the development of personal projects. They will be supported by mentors from the university and the school system. As currently envisioned, university faculty will work in K-8 classrooms to assist teachers in their efforts. Likewise, classroom teachers will teach in preservice courses sharing their knowledge and skills, and personal projects with students in the program. "Fireside chats" will be held regularly so that the technology partnership group can informally share information and solve problems.

This linkage between teacher educators and classroom teachers can provide the vehicle whereby technology is put to effective use in schools (Robinson, 1993).

Students in the teacher education program have extensive field placement requirements beginning with their first semester as undergraduates.

Ultimately, we would like the majority of these placements to be in classrooms that use technology. As a first step, we intend to place teacher interns with cooperating teachers who have been a part of the technology partnership. This collaboration will help to ensure continuity and progress in the knowledge, skills, and attitudes that students acquire.

In Summary

The building of a technology classroom has greatly enhanced the ability of teacher educators to serve as role models in integrating technology in teaching and learning. The building of the classroom contributed to the momentum for establishing a technology partnership with local schools as well. Moreover, the classroom has provided the impetus for design of a faculty development program that supports educators as they develop new and unique additions to their content areas. Ultimately, the success of the integration of instructional technology depends on faculty development. Similarly, for preservice teachers, the ability to deliver technology rich curriculum depends on the knowledge, skills, and attitudes acquired during undergraduate education.

Plans for future growth in instructional technology include the addition of a Mac lab, development of outreach programs for local teachers through a technology partnership of teacher educators and area school systems, and field experiences for preservice students that highlight the integration of technology for teaching and learning.

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Helping Teachers Become Distance Learning Teachers

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Distance learning has been an alternative to classroom instruction since the early 1800s, first in the form of correspondence courses and then more recently as audiotaped or live radio and videotaped or live television courses. Much of the history of distance learning typically has dealt with delivering instruction to young adults and, increasingly, to older adults. Both large and small colleges usually have "continuing education" departments wherein production specialists and faculty members coordinate efforts to teach students who do not go to a campus for face-to-face study. As recent technologies have become more available and affordable, distance learning courses have become more elaborate and interactive. Schieman and Jones (1993) state that "in reviewing the literature of the distance education field for the past decade and a half, one is struck by the changes from what once was largely correspondence courses to what are now sophisticated workstations and network teleconference services" (p. 3).

Today, there is a growing interest in using recently developed telecommunications and interactive video technologies to deliver instruction both within and between K-12 school systems. At the high school level, many of the techniques and strategies of traditional distance learning may apply with few modifications. If distance learning is to be delivered to the youngest school-aged children, however, there is a need for careful studies of what can and cannot be accomplished using distance learning techniques. Furthermore, kindergarten through twelfth-grade teachers, who typically have had no experience with distance learning strategies and techniques, must learn how to deliver instruction in new ways.

There is a pressing need to make technology training part of teacher preparation programs. Many of today's school teachers are self-taught when it comes to working with computers, video, telecommunications, and other recent developments such as CD-ROM materials. They have had few opportunities to learn about these developments in their teacher preparation programs. Many professors of education, too, have had to study and experiment alone in order to learn what the newest technologies can and cannot do. Both education faculty members and students will benefit from participating in a course which prepares teachers to work in distance learning environments.

This paper explores efforts by the College of Education at the University of Arizona to create a distance learning course designed for K-12 pre-service teachers. Although there are many outcomes possible in such a course, the following are seen as a few of the major objectives of a course attempting to prepare distance learning instructors:

1. To understand distance learning technologies.
2. To learn teaching techniques and strategies appropriate in a telecommunications-based setting.
3. To practice and polish communication skills needed when using distance learning equipment.

Many worthwhile class activities are possible, but these activities seem particularly appropriate to include in a course preparing distance learning instructors:

1. Modeling distance learning instructional techniques.
2. Planning and preparing distance learning lessons using current technology.
3. Teaching in and being a student in a distance learning classroom.
4. Interviewing and discussing experiences of students who have taken distance learning courses.
5. Learning from experienced mentors the practicalities of being a distance learning educator.

Several major course components must be considered when preparing teachers to work in a high-tech facility designed to enhance distance learning with younger learners. Major components to be included are: (1) helping teachers use current technologies for instructional purposes, (2) designing instructional settings that facilitate learning both inside and outside that setting, (3) creating distance learning courses or instructional modules, (4) creating a teacher/pupil context conducive for delivering and receiving educational experiences, including lectures and other instructional materials, (5) learning how to elicit full participation during interactive learning sessions, (6) providing feedback to students, and (7) planning for the evaluation of students, teachers, the course, and the technologies used.

Learning to Use Technology in Teaching

Technology gives teachers more ways to deliver effective instruction. Pittman (1991) cautions, however, that "... the various media of instruction are only tools. Their successful and productive use depends upon the quality of teaching and content, not the newest miracles of communications" (p. 31). Meade (1991) echoes this idea saying that, "computers, videodiscs, videocassette recorders—all the fancy hardware and software often lumped together under the term 'educational technology'—represent nothing more than tools to enhance teaching and learning. Without ready and willing teachers, technology can accomplish nothing" (p. 30).

It behooves colleges of education to help preservice and in-service teachers learn to use new teaching tools. The following are some of the more important pieces of equipment distance educators must learn to operate and use to good advantage.

1. A control system containing a CODEC (code/decode) for converting analog signals to digital signals. This system houses compression and decompression software, a telephone line connection, audio-video inputs, and a control panel. The unit also has software which permits the instructor to direct all local and remote cameras on the system. Additionally, the control system contains software for voice activation from distant sites that switches locations when individuals speak.
2. Monitors which show students at the remote site, and monitors which, at various times, show the instructor, graphics, videotapes being used, etc., as well as the local site students.
3. Multiple video cameras. Cameras need to be placed strategically to include everything of interest in the local and remote settings.
4. An ELMO visual presenter. This piece of equipment is a display camera capable of showing text, graphics, and three-dimensional objects. This unit operates through the control panel, making it possible for remote students to add to or alter graphics during discussions.
5. A multimedia computer with a CD-ROM, sound card, ethernet card, and speakers. This computer is necessary for using presentation software, permitting students to see and hear multimedia presentations as well as to see spreadsheets, databases, text and graphics, and statistical packages.
6. A laser printer. This can be used for the instantaneous generation of course materials, directions, etc.
7. Video cassette recorders (VCR). One VCR can be used to play instructional tapes and another can be used to videotape the class in progress.
8. A laserdisc player. This piece of equipment can be used to expose students to much of the information that is encoded in this medium today.
9. An audio cassette player for use when tape recorded sound is an important part of instruction.
10. A telephone, telephone line, and FAX machine. These items help establish voice communication with remote sites or to send visual information prior to or after live transmissions of the course.
11. Ethernet lines. Several ethernet lines (with computers) can be used by teachers and students to access Internet, Bitnet, or other carriers of telecommunications.

The Setting

There are two types of settings involved in distance learning. One is the origination site at which the instructor and possibly some of the students are located, and the other is the remote site or sites where other students participate in the educational experience. Both sites need to be fully equipped so that there can be interaction among the participants. This means that there must be cameras, sound equipment, monitors, etc. at both sites.

Teachers learning about distance teaching need to become aware of the importance of the setting as it affects learning. Price (1991) indicates several important factors which must be taken into consideration when designing video classrooms. They are: audio, lighting, room arrangement, seating, and decor. To ensure quality sound, he says that "the goals of good acoustic design are to keep out exterior noise, limit extraneous noise, and control echoes between walls, floors, and ceilings" (p. 15). Careful selection of a quiet room is a first priority. Then, the room should be outfitted with quiet ventilation equipment, quiet lighting, durable equipment, and comfortable furniture. Echoes can be controlled with acoustical ceiling tiles, carpets, and acoustical wall coverings on non-parallel walls.

Lighting should be designed so that banks of lights can be turned on or off—or dimmed—independently. Lights should be placed so they eliminate shadows on people or sets. Backlighting is desirable in improving the image on television. Indirect lighting which is bounced off a white ceiling is often desirable.

Interaction by all participants can be encouraged through the use of two-way interactive compressed video. With the relatively recent marriage of computers and television it is now possible to watch on a computer monitor either live television or taped video images as well as computer generated text, animation, and graphics. It is possible for students to sit in front of a computer at their remote sites and view their instructor on one portion of their computer screens while they work on computer generated lessons. With headsets and microphones built into individual workstations, many of the visual and hearing problems often associated with distance learning may disappear.

Regardless of the equipment, the use of a room is ultimately for the delivery of instruction, and the needs of instruction come before many other factors. Price (1991) notes that the room arrangement "needs to take into consideration the content to be offered, the instructional methods, the number of participants, and the technology to be used" (p. 17). Therefore, the setting must truly accommodate learning and people as well as equipment.

Course/Module Planning

Planning effective instruction is a key part of learning to become a distance educator. Often, a team approach to course development is used. Such teams include content area specialists, teachers, instructional designers, and technicians. Pittman (1991) says:

> First, intelligent course and program design is essential. Programming should not be designed to meet the specifications demanded by preselected medium and format. Instead, it should be designed to achieve realistic learning objectives and to be responsive to the realities of the target audience. (p.34)

There are many considerations to deal with in planning instruction that involves distance learning. Some of the major considerations are: lack of face-to-face interaction with students, student access to course references and other materials, release time to prepare an entire course in advance, preparation of graphics and other instructional aids, and emergency plans for those times when equipment is not functioning.

Schieman and Jones (1993) say:

> Most certainly the absence of face-to-face visual contact between instructor and learner affects how the instructor paces the lesson if visual communication clues are missing and the learner does not have the visual contact which would normally accompany instructor's explanations. (p. 4)

Even using two-way interactive television, teachers need to realize that in distance learning they will have little first-hand contact with their students. This may be one of the most challenging psychological aspects of teaching K-12 students through technology.

Schieman and Jones (1993) note that access to references and other resources is often a major problem for distance learners. They state, however, that "systems, such as online search facilities capable of remote data base searches, whether on magnetic tape or optical disc, are available. Ultimately correspondence packages could contain such innovations as CD-ROM discs with lessons, databases and other reference resources" (p. 9).

A course about distance learning must include instruction in all of those technologies which can be used to access and transmit course information as well as reference information.

The Teaching/Learning Context

Porter and Brophy (1988) reported major research findings concerning good teaching and good teachers. Their findings, in part, include the notions that teachers:

> ... clarify their instructional goals, know about their content and the strategies for teaching it; communicate to their students what is expected of them and why; know about their students, adapting instruction to their needs and anticipating misconceptions in their existing knowledge; teach students metacognitive strategies and give them opportunities to master them; address higher, as well as lower, level cognitive objectives; monitor students' understanding by offering regular appropriate feedback; and accept responsibility for student outcomes. (pp. 74-85)

These important teacher qualities must be discussed and made a vital part of a course which deals with distance teaching. Without the basic qualities of an excellent teacher, a distance teacher's effectiveness is questionable.

Schieman and Jones (1993) identified several of the most pertinent areas that instructional designers must consider. They are:

> ... learning styles of the learners, isolation experienced by the learner who is physically separated from the instructor, lack of ample feedback, pacing of the course, learner control over the speed of the course, lack of interaction between the learner and the instructor. (pp. 4-6)

The teaching-learning context which must be created for distance teaching is extremely complex, and teachers need to examine the psychological aspects of being a distance teacher. They also need to gain an understanding of the psychological aspects of being a student in a distance learning situation.

Teacher-Pupil Interactions

The distance teaching environment presents a challenge in terms of teachers interacting frequently with their students. Sometimes the equipment or the distance gets in the way. Price (1991) notes that "the plan and arrangement of a space will greatly affect the social behavior that takes place within it. For example, a classroom with fixed chairs facing toward a podium will support a lecture format, but will discourage group discussion" (p. 17).

Distance teachers need to learn that much of the interaction is between the students and the course materials. Winders (1988) notes:

> Since the tutor is not present to explain details, or guide the student, course material must be well designed. The student must be able to see clearly the aims of a unit, how he will achieve these aims and

> how he is progressing. Units must be structured to facilitate ordered progression. In some subjects order is inherent and the student must progress along a set path with occasional reinforcement of areas he finds difficult. For many subjects, however, dialogue and diversification are possible and in some subjects essential. (p. 156)

Bishop-Clark and Huston (1993) discuss a course in which students participated in using electronic mail, an electronic bulletin board, and electronic conferencing systems such as EDTECH and KIDSNET. From their experience in this course they state that:

> the telecommunication environment works best for students who have easy access to a computer with a modem. Several of the convenience advantages are moot if using E-mail requires a trip to campus. Students who do not type are at a disadvantage and some students simply prefer to communicate face to face. (p. 256)

Distance teachers must be among the forefront in modeling the role of facilitator—not simply transmitter—of education. Rossman and Brady (1993) report that:

> Today's changing educational environment also requires consideration in classroom design. Trends in education towards collaborative learning and an increasing change in instructors' role from the disseminator of information to becoming a 'student coach' must be taken into account when making plans for distant learning classrooms. (p. 1)

Providing Feedback

Schieman and Jones (1993) note that "Feedback has been shown to be a very powerful component in the learning process and has been perhaps the greatest obstacle to the embracing of distance education" (p. 10). Distance teachers must learn to use all telecommunications channels to provide ample feedback to their students.

Evaluation

Shaeffer and Farr (1993) state that "because it is generally accepted that teaching via technology is different than teaching face to face, ... we believe that faculty development is prerequisite to any evaluation program" (p. 79). They describe the faculty development program at the University of Wyoming as including three components—recruitment and precourse discussions with faculty, presemester seminars/workshops, and on-going coaching.

Evaluation of instructors at the University of Wyoming is both formative and summative. There is class-by-class feedback from students via the use of feedback sheets which ask students to appraise the success of specific class sessions. A midterm evaluation is conducted by the instructional designer and is a more formal evaluation. An end-of-the-course student evaluation permits students to tell what they liked or disliked about the course and the technology used to deliver it. An end-of-the-course instructor evaluation permits self-appraisal as well as an opportunity for the instructor to make suggestions which might be helpful to others.

Verduin and Clark (1991) summarize several challenges that distance educators must overcome. One challenge is that "distance educators should develop models or frameworks for judging the appropriateness of new technology applications in their field, rather than assuming that use of new distance technology will revolutionize learning" (p. 202). Planning a course to help teachers become distance educators is a both a theoretical and technical challenge. Not only must there be a firm foundation of teaching and curriculum planning, but there are a host of other teaching/learning factors which must be addressed. On top of this is the need to help distance teachers learn to effectively utilize today's rapidly evolving technologies in the absence of empirical studies which validate their value. It is hoped that the course under development at the University of Arizona will ultimately prepare teachers who are capable of effectively using all of the tools that technology is making available to teachers today.

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Integration of Technology and Education: A Student's Perspective on Distance Learning

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My Mother says I came out of the delivery room wanting to be a teacher. My desire to teach continued as I grew. As a child, I organized classrooms, recruited students, and taught at every opportunity. I can't remember a time I didn't have the desire to become an educator. I want to be able to help children to learn. I want to be a teacher!

Two years ago, as a senior at San Marcos High School, my vision of education and teaching was expanded. I was introduced to both the concept and the reality of distance education. I was invited to be present during a "hot test" of a completely interactive classroom at San Marcos High School.

I was enthralled with the interactive television (ITV) classroom and the arrangement of the technology within the classroom. I was most impressed with the comfortable feeling I had when the system was activated. There was not a stiff, delayed, or "video" feeling during transmission. I had never had a classroom experience to compare with what I was experiencing that day.

The transmission was spontaneous and natural. I felt I could readily communicate with the individuals at the other sights. I began to imagine many applications for the use of this technology. I decided at that time, I wanted more training in the use of interactive technology and distance learning.

I am currently in the process of making both of my dreams a reality. I am 18 years old, and I am a sophomore at Southwest Texas State University located in San Marcos, Texas. I am working toward a degree in elementary education with a specialization in music.

Attending Southwest Texas State University provides me with an education that meets my individual goals. Along with my education classes I also have the opportunity to learn how to integrate technology in the classroom. I feel my educational opportunities at Southwest Texas are unique for two reasons. First, the instruction from the Education Department is respected both within the state of Texas and nationwide. Second, Southwest Texas is a founding and actively participating partner in the TeleCommUNITY ITV Network.

The TeleCommUNITY ITV Network was established in San Marcos, Texas in 1991. The network is a collaborative partnership between the San Marcos Consolidated Independent School District, Southwest Texas State University, Gary Job Corps, and Century Telephone Company. Each TeleCommUNITY Network partner shares the cost of maintaining and operating the network.

The ITV classrooms are located in the San Marcos High School, Bowie Elementary School, Gary Job Corps, the Southwest Texas State University education building, and the university library. The various sites are linked by digital fiber optics. Other classrooms are in the planning stage.

An educator teaching a class inside an ITV classroom can be simultaneously projected into any or all of the other classrooms. A teacher can instruct students at many different sites simultaneously. The students attending the class in the originating and remote classrooms can communicate equally with the instructor. The students can also interact freely with one another.

The name interactive television literally applies to the state-of-the-art TeleCommUNITY classrooms. Students and teachers in San Marcos freely interact with one another via the only full-motion continuous presence interactive television network in the state of Texas.

ITV technology permits students enrolled in one institution to obtain instruction from another institutional partner without leaving their own campus. This is distance learning. Distance learning uses technology for transferring concepts, skills, and curriculum to students, who are separated by distance from their instructor.

The TeleCommUNITY ITV Network was originally designed with three specific benefits in mind:

1. Present high school students with the option of taking a course that would furnish credit for both high school and college. These dual enrollment courses would originate at the University and would be simultaneously taught to a class of Southwest Texas students.

2. Give college and high school teachers the opportunity to increase their professional skills and develop new skills related to technology. The inservice and professional development projects could include collaborative efforts between university professors and high school teachers. These educators could share a classroom and team teach though separated by distance.

3. Provide the students of Gary Job Corps, a federally funded institution, with the opportunity to participate in high school classes while remaining on their own campus. They could qualify to receive a high school diploma instead of receiving a General Equivalency Diploma (GED).

At first glance, the ITV classroom appears to be a traditional classroom. A closer inspection reveals a multimedia teaching platform at the front of the room and two groups of television monitors. Each group consists of three television sets. One group of sets is arranged beside the teaching platform, facing the classroom, and viewed by the students. Students can view a teacher in a remote classroom, distant classmates, audio-visual presentations, or demonstrations. All these scenes can be watched simultaneously.

The other grouping of televisions is mounted from the ceiling over the heads of the students or placed on a stand in the rear of the classroom. This group of television monitors is stationed to be viewed by the teacher. Remote classrooms, presentations, or the teacher's own performance can be viewed on these sets.

Three small cameras are stationed within the classroom. One camera focuses on the teacher, one focuses on the class, and the third aims straight down onto the teaching platform. The cameras are maneuvered and directed by fingertip touch controls located on the platform.

There is an option available which attaches a tracking device to one of the cameras. The teacher can wear a tiny, wireless chip that permits the camera to follow her movements around the classroom automatically. She can move freely, but always be within sight of her remote students.

Graphs, charts, demonstrations, handouts, homework, writing samples, small items, or experiments can be viewed by the camera mounted directly above the teaching stand. There is no more need for dusty chalk or smelly markers! The camera has very simple controls with wide angle and telephoto ranges available. I can easily imagine a long distance show and tell hour.

All these cameras, television sets, and controls can seem intimidating, but I have found them very easy to use. My fellow students and I quickly learned to manipulate the cameras during a class presentation. The teaching platform and the controls are designed for simplicity of use.

The teacher wears a wireless microphone and small choir microphones hang from the ceiling of each classroom. These microphones are so sensitive a student whispering can be heard by the teacher many miles away. This feature has obvious advantages to the teaching staff!

As with the video transmission, there is no time lapse in the transmission of sound. This creates a very comfortable, conversational atmosphere in the remote classrooms.

The TeleCommUNITY Network also utilizes a data link that allows the classroom computers in distance locations to share screens and easily transfer data. These data transmissions travel over the same fiber optic facilities the voice and video transmissions use.

The teaching stand contains a VCR and multimedia laser disk player. Audio-visual aids can be played at one location and seen at another. The VCR is available to record anything showing on the television monitors. Classroom activities can be recorded. I think these tapes could be extremely helpful when a test is administered, a parent conference is conducted, or a teacher is being evaluated.

Some circumstances might allow the technological delivery to overshadow the message of the instructor. Students could easily focus on hardware and classroom facilities instead of the instruction being delivered. The comfortable classroom setting in San Marcos and the easily maneuvered machinery does not overwhelm the instruction. Instead it creates a warm "you are here and I am there" feeling. Students and teacher can develop a friendly, personal atmosphere, despite the many miles of physical separation.

Last semester, I had the opportunity to be a student attending a lecture in a remote classroom. One of my professors, Dr. Judy Leavell, had my class attend a lecture by a visiting professor. We were in an ITV classroom on campus and he spoke from the Professional Development Center at Bowie Elementary. Two groups were instructed simultaneously in a very efficient, competent, comfortable manner. I enjoyed watching the ITV system come alive in my own classroom.

I believe most students are completely at ease in a

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classroom filled with technology. Many of them have experienced television, videos, camcorders, video games and computers both at home and in school. Technology in the classroom is a natural for these students. I've even wondered if students will not perform at an improved level in a multimedia classroom. After all, these children frequently find their entertainment with the same technology used in the classroom. They may watch videos, play interactive video games, use computers, and view futuristic shows that portray people communicating through technology.

Mr. Curtis Wubbena is a teacher at Bowie Elementary in San Marcos. He has taken his fourth grade class into the ITV classroom at Bowie several times this school year. According to Mr. Wubbena, the children love being in the room and are eager to go back. The first time the children visited the classroom they focused on watching themselves on the monitor screen and wanted to understand how the cameras function. However, during later sessions in the ITV room, the children appeared comfortable and remained on task. Mr. Wubbena feels his class has no fears or qualms about using the technology available to them.

Mr. Wubbena's class recently held a special activity using the ITV Network. Following a workshop on the writing process, the fourth graders made presentations from the teacher's stand and were observed by education students at Southwest Texas. The elementary students and the future teachers then discussed the writing process with one another using the interactive network in their classrooms. Mr. Wubbena feels his students are gaining valuable experience in learning to make public presentations.

I also had the opportunity to be a presenter over the ITV Network last semester. Three of my classmates and I presented a group project on distance learning and more specifically the TeleCommUNITY Network. Using two classrooms separated by several miles, we were able to demonstrate the system while reporting on our research.

I thoroughly enjoyed doing the presentation. I learned more about the ITV system and I discovered how quickly we could familiarize ourselves with the controls operating the cameras and sound. It was amazingly comfortable to present our research on camera. I especially enjoyed the question and answer period. I liked the challenge of listening to questions, formulating answers, and focusing cameras at the same time. Given the number of students who came up at the end of class to experiment with the teaching platform and the cameras, I think the class enjoyed the technology.

I think the ITV distance learning system is the education environment of the future. I can imagine the advantages of having this system in wide use. Children and adults would be able to receive a valuable a education wherever they might live. Rural students could expect to receive the same diversity of classes urban students receive. I feel providing each child an equal chance to obtain a quality education should be our greatest goal.

Other advantages of distance learning could be in allowing advanced high school students to begin taking college classes without leaving their high school campus. This occurs every day in San Marcos. Challenged students could receive curriculum tailored to their learning styles. Students everywhere could benefit by taking specialty classes.

Another value to the system might be to ensure classes can be taught by subject matter experts. Latin, Russian, and microbiology classes could be offered and these classes could be taught by subject matter experts. When I was in high school my English class was taught by a track coach. I vividly remember precious class time being spent in discussions about track meets.

Distance education systems will probably only succeed as teachers are prepared to use the technology available in the classroom. The Southwest Texas Center for Professional Development and Technology, at Bowie Elementary School, is available to assist in training educators. The center includes an ITV classroom.

In 1992, Southwest Texas was one of the eight universities selected to participate in a Texas Education Agency grant. The Agency wanted to develop a new teacher education program which was field based, technology rich, and innovative. The grant's goal was to restructure teacher education, prepare education majors to student teach, and to bring technology into the classroom. Several elementary and Jr. high schools participate in this program with Southwest Texas.

Patricia Curtin, Professional Development Center director explained the "block classes" available to Southwest Texas education majors. Twice a week education majors enrolled in block classes learn about teaching through interaction with children in a real, live classroom. The first part of the day is spent assisting in a classroom supervised by an inservice teacher. The block students then meet with each other in a separate classroom and are instructed by an education professor from Southwest Texas.

This program allows education majors to receive instruction from the University, while gaining valuable hands-on experience in a real classroom. Another advantage is spending time with teachers already in the field. The inservice teachers do so much to educate future teachers. When the time comes, student teachers will be veterans in the classroom, not newcomers. I want to be able to participate in this program next fall.

My dean, Dr. John Beck, discussed with me the future of education and the changes he envisions. According to Dr. Beck, ITV will change the traditional methods of classroom teaching. My imagination expanded after talking to Dr. Beck, and I thought about the need for discipline in a remote classroom. I think one solution is a specially trained expert.

A "Classroom Management Specialist" (my proposed title) would assist the teacher in the remote classroom. A Classroom Management Specialist would need to be well trained. I suggest he or she have an associate's degree. The degree would need to focus on developmental psychology, sociology, appropriate discipline techniques, and general education studies. The specialist would confer with the teacher to assist in meeting educational goals. Classroom behavior could be monitored while using the ITV system. Individual attention and help could be offered by this teaching assistant.

I'm sure as the innovations in technology continue many changes in the structure of the classroom will occur. I appreciate Dr. Beck's stimulation of my thinking about how I would operate a remote classroom.

In three years, I hope to have a classroom of my own. Before I was introduced to the ITV system, I envisioned myself as a local school teacher. I imagined myself teaching and influencing students within my own community, but with an ITV distance learning system I could influence and teach children anywhere in the world.

Through this system children and their parents in third-world countries could be educated. Perhaps, we could overcome bigotry with multicultural remote classrooms. Even the regional differences in the United States could be better understood if students shared classrooms. We might even improve the image of school most students have now.

The TeleCommUNITY Network has been used successfully to help "at risk" high school students in changing their opinion of school. In 1992 under a grant called PATH Math(Partnerships for Access to Higher Mathematics), San Marcos High students were taught pre-Algebra skills over the system. The students had measurably increased math skills and an improved attitude about school(Lloyd, 1992).

Perhaps, we could wipe out illiteracy. The whole world could become a better place to live. There are children around the world, and in our own country, who currently have no means of receiving a quality education. Perhaps now, we can provide this education. The TeleCommUNITY Network suggests we "move the information, not the people."

Educators are in the unique position to develop the leaders of tomorrow. Until now, an educator's influence has been almost limited to a single school. What a difference technology makes! Now children anywhere can be instructed and assisted. I want to be a part of this vision. I want to help create the curriculum and techniques used with the multimedia ITV system. I want to be able to influence and change lives.

The TeleCommUNITY ITV Network can sound futuristic, but in San Marcos it functions everyday. Classes are being taught using the multimedia system. I know I sound like an idealistic student, but the ITV system really works. I see it happening. I'm grateful for the exposure I have had to the TeleCommUNITY Network. And I am grateful for the training I am receiving at Southwest Texas State University. The education of tomorrow is here today. I am excited to be a part of the future of education!

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Nicole Leigh Morgan is an undergraduate teacher education student at Southwest Texas State University in San Marcos, Texas.

Two-way Televisoin: Linking Preservice Teachers to Real World Schools

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Since 1986, the University of Massachusetts Lowell's two-way television Instructional Network (McDevitt & Mazzola, 1990) has been providing curriculum enhancement and staff development opportunities to elementary and secondary schools in the Northeast corner of Massachusetts. Currently, the Instructional Network links eleven geographically separate public school districts and four University campuses with simultaneous, interactive video and audio signals; teachers and students at one location can both see and hear their counterparts at other locations. Ongoing programs are designed to update teacher content knowledge in specific science topics, introduce advanced level high school science students to the vast resources of the University of Massachusetts Lowell, or allow elementary teachers to share expertise between and among individual school districts. While these types of programs typically receive the most attention among distance learning researchers, telecommunications technology also has the potential to provide colleges of teacher education a window to the real world of schools from pre-K to post graduate level. At the same time, the technological links between schools and colleges also have the potential to link two distinct areas of research: distance learning and teacher education. Recognizing this, the Instructional Network has designed a field experience model which utilizes two-way television to prepare preservice teachers for the real world of schools

Researchers in the field of preservice teacher education (Dixon & Ishler, 1992; Holmes Group, 1990; Levine, 1990; and others) present professional development school models, similar to the clinical model of medical schools, to improve the preparation of preservice teachers. These models suggest that early field experiences can provide meaningful connections between preservice teacher education programs and the real world of schools. Drawing on perspectives from research in teacher education, specifically that done on professional development schools and distance learning, this paper will describe the technology-mediated early field experience model currently in place at the University of Massachusetts Lowell. The theoretical framework the model is based on suggests that effective links between colleges of teacher education and the real world of schools can be forged from theories of teaching education and distance learning to guide aspiring—and veteran—teachers as they develop a repertoire of effective teaching practices.

Methodology

The Miles and Huberman (1984) multimethod design provides the conceptual framework that informs this study. It is becoming more apparent that a multimethod research design is demanded by technology-driven educational projects. The need to gather useful data that is both formative, to inform planners during the innovation stage, and summative, to assess overall program effectiveness is ongoing and significant. Conceptually, this study includes both qualitative and quantitative procedures to insure that the data collected are both exploratory and confirmatory. The cornerstone of this research is a description of the two-way television early field experience model. In a first teacher to assist in meeting educational goals. Classroom behavior could be monitored while using the ITV system. Individual attention and help could be offered by this teaching assistant.

I'm sure as the innovations in technology continue many changes in the structure of the classroom will occur. I appreciate Dr. Beck's stimulation of my thinking about how I would operate a remote classroom.

In three years, I hope to have a classroom of my own. Before I was introduced to the ITV system, I envisioned myself as a local school teacher. I imagined myself teaching and influencing students within my own community, but with an ITV distance learning system I could influence and teach children anywhere in the world.

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attempt to test the model, data gleaned from this description are confirmed and analyzed via data collected during a comparison of students' assignments and analysis of students' surveys.

Research Questions

This study seeks to answer the following research questions:

1. Do televised, early field experiences provide better opportunities for preservice teachers to observe veteran teachers implement educationally sound pedagogical practice than the more common, in-person classroom observations where students travel to local elementary and secondary schools?
2. Are there differences between televised and in-person classroom observations with regard to the amount of time spent in the post-observation conference and the quality of the post-observation conference between the preservice teacher and the classroom teacher?

Sample Selection

As a data reduction procedure, sample selection serves to insure the relevance of the data to the problem under study. The sample in this study is comprised of forty-nine students in the Graduate Program in Teaching who will earn a master's degree in June 1995 and be eligible for Massachusetts certification as elementary teachers. The students range in age from 22 to 50+ years. Four students are male and forty-five are female. Students enter the program with at least an undergraduate degree, generally in the liberal arts.

Instrumentation.

In this study, data were collected during a comparison of selected written assignments from both television and in-person classroom observations. Additionally, quantitative data were collected from a survey designed to assess students' perceptions of their in-person and televised observations.

Technical Configuration of Instructional Network

The Instructional Network includes the four University of Massachusetts Lowell campuses, linked via fiber optic cable, and eleven school systems, connected through existing subscriber cable companies. Since the University has buildings in a city where the cable company serves three contiguous communities, we were provided access to those schools' institutional networks as part of the license agreements. In the other eight cases, the University uses microwave to transmit and receive signals between the hub sites of the two cable companies that serve those communities. Technically, the network is a combination of coaxial cable, fiber optic cable, microwave, and satellite technologies used to transmit video and audio signals.

Classroom equipment varies from a deluxe three camera configuration, using a special effects generator and teacher console to control the cameras with no technician needed, to a more basic—and prevalent—portable configuration, using modulators and demodulators, audio mixer, microphones, a television, and one camera operated by a technician. There is no charge for any Instructional Network program, nor are there yearly subscription charges.

Program Description

While early field experiences, such as observations and practice teaching, are a part of every teacher education program, the effectiveness of these experiences has been the subject of much discussion. Among the common concerns, and the concerns that spawned this study, is the quality of the observations at school sites, the lack of expert schoolteacher involvement in the preparation of future teachers, and the lack of meaningful communications between colleges of education and the real world of schools.

At the College of Education in the University of Massachusetts Lowell, elementary schools are selected for students' early field experiences by College faculty. The individual classroom teachers chosen to be observed are either selected by school personnel or by happenstance. All schools are sent a copy of the student observation handbook which details the focus of each observation and the corresponding written assignment. Predictably, then, those teachers more carefully selected may be aware of the pedagogical focus of the visiting students' observation and can thus prepare for the students. Teachers observed by mere happenstance, however, are probably not aware that the students will be looking for a specific behavior or strategy during the observed lessons. It follows then that preservice teachers may not benefit from early field experiences if cooperating teachers are not providing experiences that demonstrate pedagogical theories discussed during methods classes. In other words, what they see is what they get, but if it isn't what they are asked to look for, it may be of little value to them.

Researchers share this concern and suggest that novice teachers need to observe the effects of expert teachers' actions in the classroom in order to develop schemata that students will call on later to make decisions and plan actions (Cotton & Sparks- Langer, 1993). Moore, Tullis, and Hopkins. (1990) believe that early field experiences need to be concrete, followed by an opportunity for feedback and reflections, and Zeichner (1985) believes that the early field experiences must be linked with the content methods courses.

As a result of these concerns and the availability of conceptual frameworks developed by teacher education researchers to guide practice, TWO-WAY TELEVISION: Linking Preservice Teachers to Real World Schools seeks to expand the Professional Development School concept and provide more opportunities for classroom teachers to work collaboratively with college faculty to share their expertise with preservice students without leaving their own classrooms.

The program begins when elementary and secondary school teachers and College of Education faculty participate in curriculum planning sessions. At these sessions, University faculty and expert classroom teachers collaboratively plan lessons that will demonstrate pedagogical theories studied by students as part of the preservice curriculum.

The process continues when lessons that the teachers conduct in their own classrooms are transmitted via two-way television to College of Education students located at the University campus. Teachers and students then extend the learning through a follow-up discussion of the televised lesson. For example, a third grade teacher taught a lesson to his students that modeled effective questioning strategies. Since the lesson was scheduled for the last period of the school day, the two-way television system was shut down while the teacher dismissed his students. The teacher then returned to his classroom where the two-way television system was turned on again so that the college students and the teacher could discuss the lesson just completed.

Results of Written Reflections

Data presented in the two tables below were gleaned from the preservice teachers' written reflections on their four classroom observations. Direct quotes from their reflections are in italic as supporting documentation. For all four observations, students observed a teacher in-person and a teacher via two-way television, using the same criteria for both. The focus of the first two observations was questioning strategies. The focus of the third and fourth observations was teaching strategies.

Questioning strategies (in-person). As Table 1 indicates, 31 students observed teachers whose questions were limited to the lowest level of cognition. That is, the questions asked of elementary students in the classrooms being observed did not require them to think beyond the level of straight recall. Only eight college students observed teachers who asked questions ranging from the lowest to the highest level of cognition. For the most part, the college students felt the teachers they observed were not prepared to model effective questioning strategies. In some cases, students reported that the classroom teachers were not even aware that teacher education students would be in their classrooms to observe.

> *From the questioning I have observed in five weeks we have been observing, much of it has been to keep students' focused on doing, and learning the activity at hand. I have not observed many higher levels of questioning....*
>
> *What struck me most about this assignment was that every question I wrote (and I was writing furiously) was a low level question, was asked by the teacher, and had a wait time of (maybe) one second.*

Many students were concerned that teachers did not wait an adequate amount of time between asking the questions and calling on students to answer. Adequate wait time is considered central to fostering critical thinking skills and providing equal opportunities for all students to participate actively in class.

> *The children were bombarded with questions, one right after the other, with no wait time.*

Questioning strategies (2-way TV). In comparison to in-person observations, the reflections on the television lesson indicate 35 of the 49 teacher education students observed the teacher employ a range of questioning skills from the lowest to the highest level of cognition. Further, 19 of the college students were so impressed with the teacher they observed on television that they quoted many of his responses to his student's answers or expressions he used to encourage students to think critically before they responded.

> *The research that I have read always stressed the importance of wait time. It is one thing to read about it, but to see it first hand puts it into a better perspective.*
>
> *However, I am pleased that I had the opportunity to see a competent teacher in action...*

Table 1
Questioning Strategies

Observation I n=49

Criterion	In-Person Observation	Two-way Observation
Observed low level questions	31	0
Observed low & high level questions	8	35
Quoted teacher being observed	0	19

Teaching strategies (in-person). As Table 2 indicates, 9 teacher education students observed teachers who used multiple teaching strategies during scheduled early field experiences at school sites while 31 students observed teachers who employed a single teaching strategy. Data indicate that when only one strategy was observed it was either teaching from a textbook, reviewing homework, or independent student worksheets.

> *While watching the afternoon two-way video conference, I observed much more powerful, engaging, effective teaching strategies. [As compared to the in-person observation conducted that same morning.]*
>
> *Observing last week's [TV] lesson with Mr. Mack confirmed my belief about the importance of using various strategies in the classroom.*
>
> *Our observation of Mr. McEnaney's science lesson confirms this point. [Science is not taught effectively using textbooks and teacher-talk exclusively.]*

Teaching strategies (2-way TV). In comparison to in-person observations, the reflections on the television lesson indicates 41 of the 49 teacher education students noted the teacher employed multiple teaching strategies during his lesson. Specifically, students noted the use of lecture, effective hands-on use of an overhead projector (to illustrate parts of a live root system) and real objects, and data collection devices.

> *Real bees, WOW, what a lesson.*
>
> *I thought it was a terrific lesson that demonstrated*

many different types of teaching strategies (hands-on, lecture, cooperative learning)."

> *I am very glad to have had the chance to observe this lesson today. I feel it was valuable seeing a full lesson and being able to see different teaching strategies. I wasn't really able to do this in school this morning.*

Table 2
Teaching Strategies

Observation 2 n=49

Criterion	In-Person Observation	Two-way TV Observation
Observed multiple strategies	9	41
Observed single strategy	31	0

Post-Observation Conferences

The data confirm that observations via two-way television are far more likely to give preservice education students more opportunities to see specific strategies being effectively implemented in the classroom than traditional in-person observations. Another area in which two-way TV observations can prove more effective is post-observation discussion and feedback. Again, with in-person observations, cooperating teachers may or may not spend time discussing what the preservice student has observed. Even those who do make themselves available may not be prepared to analyze what happened in class in terms of the methodology on which the student is asked to focus. With two-way TV observations, the opportunity for focused discussion is part of the instructional design. Furthermore, those students who are reluctant to ask questions benefit from the discussion raised by other students' questions.

> *I suspect, although I didn't get a chance to ask the teacher...*
>
> *I do wish she had more time to talk with me one-on-one, but I realize she can't. These children are constantly demanding attention.*

Results of Survey

Survey results of the 49 students who observed the lessons on questioning and teaching strategies both in-person and on television conflict with data gleaned from the students' written reflections. For example, 43 students either agreed or strongly agreed with the statement that they would choose in-person observations over two-way television observations, although few students reported they were able to observe educationally sound pedagogy in practice at school sites and that often the teachers were not aware that students would be visiting their classrooms. Further, while 23 students indicated they did not ask questions if the teacher was not friendly, 38 students disagreed with the statement that they did not ask questions because the teachers are too busy. Interestingly, 23 students believed television observations were more inconspicuous than in-person observations while 17 neither agreed nor disagreed.

Discussion

A systematic review of distance learning research reveals no models of colleges of teacher education using any type of video technology that allows college students to observe elementary classrooms without leaving their college classrooms. The University of Massachusetts Lowell model appears to provide a cost effective, educationally sound, and technically reliable instructional delivery system to improve preservice teacher education programs. Results of this preliminary research suggest that technology-mediated observations, collaboratively planned by college faculty and classroom teachers, can provide more opportunities for preservice teacher education students to observe veteran teachers implement educationally sound pedagogical practice than the traditional in-person classroom observations where students travel to local elementary and secondary schools. While, as the discrepancy between students' reflections and their survey responses suggests, nothing can replace the immediacy of being physically present in a classroom full of children making varied demands on their teacher, clearly a two-way television model can provide an element of quality control among the early field experiences of preservice education students. Additionally, although data from student reflections and survey responses are contradictory in regard to opportunities to discuss and analyze their observations, designing the technology-mediated early field experiences to include a common designated time for students to reflect on the observed lesson and then discuss their perceptions of the classroom events with expert teachers satisfies the concern of teacher educators for more meaningful links between college faculty and classroom teachers.

Future research is needed to:

- provide guidelines for scheduling in-person and technology mediated observations that provide just the right balance of in-person observations which provide the immediacy of "being there" to experience firsthand the realities of a classroom full of children and two-way television observations which provide specific pre-determined examples of expert teaching;
- design strategies to ensure novice and veteran teacher discussions are beneficial and relate to the pedagogical methods under study;
- identify and examine the characteristics of effective technology-mediated early field experiences;
- identify the variety of technologies currently available to link colleges of teacher education to the real world of schools;
- test "traditional" strategies (on-site meetings, mailings, telephone calls, etc.) and emerging technologies (e-mail, electronic bulletin boards, fax machines, subscriber cable public access and education channels, etc.) to ensure that all cooperating teachers, in person and broadcast, are made aware of the pedagogical foci of college students' observations.

Beyond the findings reported here, results from a study of technology-mediated observations provide an opportunity for university and school-based personnel to discuss a model for early field experiences which takes advantage of distance learning capabilities and weds them with the professional-development concept to ensure a meaningful link between preservice teacher education programs and the real world of schools. The model developed at the University of Massachusetts Lowell may become the foundation on which participants can build professional development models at their home institutions that will allow both inexperienced and veteran teachers to continually broaden and enhance their teaching repertoire through direct observation of and discussion with expert teachers employing successful strategies in the real world of the classroom.

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Preparation for Field Experiences with Videotaped Microteaching

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Microteaching, begun in the early 1960's at Stanford University, reached its peak in the late 1960's and early 1970's. In its purest form, students teach a scaled-down lesson of five to twenty minutes while focusing on particular teaching skills, such as questioning, presentation, or providing feedback to students. After teaching the lesson, the students receive feedback on their performance from supervisors and peers and by viewing a videotape of their performance (Perlberg, 1988). Microteaching is most often used to teach discrete skills before interning and the first year of teaching. Research results on the effectiveness of this technique have been mixed, with no significant increases in skill attainment generally being observed (Cruickshank and Metcalf, 1990).

This paper describes a different use of microteaching, shifting the emphasis from teaching discrete skills to preparing students for successful field experiences. Our goal is to help them coordinate the skills, concepts, and values learned in the college classroom into an integrated, harmonious, effective lesson in the public school. We first outline the theoretical basis for this approach and then suggest principles for effective implementation.

Theoretical Basis for Microteaching

Cruickshank (1986) describes several levels of experience in teacher education: (1) Concrete-real—"first-hand" experiences such as student teaching and certain field and clinical experiences; (2) Concrete-modeled—simulated teaching experiences, such as role-play, microteaching, and simulations; (3) Vicarious—observations of others teaching live in classrooms or on tape, and (4) Abstract—lectures, case studies, discussions, traditional computer-assisted instruction, and recitations. Traditionally, most teacher education programs have relied heavily on abstract instructional strategies prior to student teaching, mainly lecture and discussion (Cruickshank, 1986; Smith, 1987), with few, if any, concrete-modeled experiences. As the number of concrete-real experiences increases (Evertson, 1990), microteaching is one of several possible concrete-modeled experiences that can allow preservice students to practice their teaching in a simplified and risk-free environment. Videotaping the microteaching augments the experience, providing the students with more detailed feedback on their performance.

Overview of the Microteaching Experience

In each of our methods courses we have adapted traditional microteaching to meet the needs of students preparing to complete their field experience. In the reading methods course, students microteach two lessons several weeks apart using a specific reading technique such as Directed Reading-Thinking Activity (DR-TA). After each lesson the instructor and students have individual conferences to set goals for improvement. The microteaching sessions serve as a rehearsal for a similar reading lesson in an elementary classroom taught later in the semester.

In a combined language arts and general methods course, students first microteach a prewriting lesson. They set teaching goals for the semester at an individual conference with the instructor and then go in teams of three to teach ten lessons in an elementary classroom or after-school program. At the end of the semester, they microteach another prewriting lesson and have a conference with the instructor to evaluate their progress on their individual goals.

In both classes, the first microteaching experience takes place within the first three to four weeks of the semester. The instructor first demonstrates the type of lesson or teaching skill to be included in microteaching. Each student then plans a 10-12 minute lesson and receives feedback on the draft from the instructor. Teaching teams of 3-5 students sign up for one hour in the microteaching laboratory. On the day they microteach, the team members bring additional students to form a class of at least five learners and teach their lessons which are videotaped by a technician. The microteacher and learners view the videotape and complete a review form. A few days later, the microteachers meet the instructor in individual conferences during which they view the tapes, discuss the self and peer reviews, and note strengths and weaknesses. The conferences end with the students setting goals for improvement.

This structure allows students to practice for field experiences in advance, which eases their anxiety. They also microteach with their field experience team, which promotes a more collaborative environment throughout the field experience. By teaching the second microteaching session with the same team, team members are more apt to recognize and comment on improvements in one another's teaching.

Suggestions for Implementing Microteaching

As promising as videotaped microteaching is for easing the transition into field experiences, there are a number of possible pitfalls that can limit its effectiveness. In the section that follows, we offer suggestions for avoiding the pitfalls and making microteaching as effective as possible.

Consider the Range of Possible Experiences and Formulate Clear Goals

One of the potential pitfalls in using microteaching stems from its history as a behavioral approach that narrowly focuses on discrete teachable skills in presentation or feedback (Perlberg, 1988). The effectiveness of microteaching for such purposes is questionable, but microteaching has a much broader range of possible uses. It can be used to build student confidence before a field experience, to acquaint students with the evaluation system that will be used during student teaching or their initial year of teaching, to practice a teaching technique, or to encourage reflection and enhance decision-making ability.

We strongly advise formulating a clear sense of the intended purpose of each microteaching assignment. In our classes, we use microteaching for different reasons and expect different benefits. One of us uses it primarily to build confidence before field experience and to encourage reflection. Another pinpoints specific reading strategies for students to rehearse in the lesson and later complete in a field setting. Still another uses microteaching to introduce an assessment instrument used later in student teaching and the initial teaching year.

Knowing the goal gives direction in structuring the experience to achieve it. For example, when microteaching is used for strategy rehearsal, a specific outline and structure for the lesson is necessary to include all of the desired teaching elements. When using it for confidence-building and reflection, more flexibility and freedom can be given to students planning lessons.

Communicate Goals Clearly

It is not enough for you to know why you want students to microteach; your students must have a clear understanding as well. Without clearly identified goals, the instructor and students will go through the motions of microteaching but may not reap the benefits. Students may resist the method, seeing it as just another requirement or a waste of their time. There are several ways we communicate our goals to students:

- Give the students handouts detailing goals for the experience. "Our primary goal is for you to teach a Directed Reading-Thinking Activity (DR-TA)." "After two microteaching lessons, you will describe the sections on the Teacher Performance Assessment Instrument (TPAI) used to evaluate your teaching."
- Use self-evaluation forms tailored to be consistent with the stated goals. For example, the students who are practicing the DR-TA complete a form asking about steps required for that technique, and the students working with the TPAI complete peer and self-evaluation forms using the exact headings found on the assessment instrument.
- During one-on-one instructor-student conferences, ask students about their reactions to microteaching and whether or not they feel they have achieved the preset goals. Talking with students about their reactions helps us see if the exercise met its objectives, and also gives students a chance to express their perceptions of the experience, leading to possible modifications in future classes.

Provide Structure for Peer Feedback

Have all the students participating as learners in the lesson complete questionnaires concerning easily observed instructor behaviors. For example, the form for a Directed Reading-Thinking Activity includes questions like, "Did the teacher encourage creative predictions? How?" or "How frequently did you notice the teacher asking learners to prove or justify their predictions?" In addition, students should be called on to identify specific things they liked about the lesson and suggest one or two items that could be improved. It is important that the feedback be specific so the teachers recognize what they did right and know how to do it again. For example, if a participant says, "You really made this lesson fun," the teacher may not know what made it fun. But if the participant says, "I liked it when you showed us the funny picture from the book before you read it," the teacher knows precisely what worked.

Another way to improve student feedback is class practice. One of us shows a video of a microteaching lesson and has students fill out the feedback forms. Then they discuss their reaction, and the instructor points out helpful responses made by class members and provides model feedback when needed. Using a videotape rather than a live demonstration for practice feedback allows you to replay it to see how accurate student evaluations are. It takes a few brief practice sessions of this type before students begin to feel comfortable about what they are supposed to do.

Provide Structure for Self-Evaluation

Students also need structure for their self-evaluation. Without clear elements to look for when viewing the videotape of their lesson, students will often fixate on things like their appearance or a repeated gesture. Certainly general appearance and distracting gestures are important, but there are often more important things we want our students to notice as they see themselves on tape.

Perlberg (1988) considers video feedback the most important part of the microteaching process because it activates a "dissonance phenomenon" whereby students become aware of a gap between what they intend to do or be during teaching and what actually occurs. Once they confront the dissonance, an "arousal process" begins as they become motivated to narrow the gap. He suggests that viewing videotape is "the main facilitator and accelerator of change and growth." (p.8)

Just as with peer feedback, we have found that specific guidelines help our students zero in on the points we are interested in. One of us has students rate each lesson segment as "Knocks our socks off," "Okay for now," or "Back to the drawing board." Sometimes we have students count their filler words (uh, okay). In one class, students complete a rating scale based on a standard assessment instrument including such items as "maintains high time on-task," "circulates to check student progress," and "affirms correct answer quickly." Students rate each item on a five-point scale ranging from "needs improvement" to "above standard." All of us require students to identify behaviors they would like to work on to improve their performance. These tasks help students to view their performance in the light of the goals we have for them rather than basing their evaluations on initial impressions.

Optimize the Student-Instructor Conference

One of the most time-consuming aspects of microteaching is the one-on-one conference. It is tempting for instructors to allow microteaching to just happen and to rely solely on peer feedback and self-evaluation. While students would get some benefit out of such an experience, for microteaching to achieve its full educational potential the instructor's expertise is required (Cruickshank & Metcalf, 1990; Frager, 1985). In an informal survey taken after the microteaching experiences in one of our classes, almost all of the students rated the instructor conference as the second most effective factor in self-evaluation (after the videotape viewing). Most of us in teacher preparation programs are experienced in observing teaching and identifying strengths and weaknesses. We can see what problems are attributable to a lack of experience and will correct themselves and which problems need immediate attention. We can help our students clarify their own goals, and so help them to improve more dramatically over the course of a semester. For these reasons, it is crucial that conferences be held with students.

Given that we are committed to having conferences, the question then becomes how to structure them to make the best possible use of the time they will take. We have found several things to be helpful:

- Select blocks of time for scheduling microteaching conferences rather than scattering them out one or two at a time. This approach allows you to arrange for a VCR for playback two or three times instead of twenty, saving scheduling time. We have found that approximately 30 minutes per conference allows plenty of time for viewing and discussing the 10-12 minute tapes without anyone feeling rushed.
- Make sure students know what the conference is for and that they are prepared. We ask our students to have completed the following tasks before coming to the conference: teach the lesson, review written and oral feedback from their peers, view their tape as many times as needed, and complete their self-evaluation form. They are requested to bring all the peer feedback forms, the self-evaluation form, and the tape to the conference. If they aren't ready, they have to reschedule the conference. We have found that being clear about these expectations has worked well, with only one conference having to be rescheduled during the past academic year.
- Make a checklist or protocol for yourself to guide the conference. We usually start with an open-ended question like, "How did you like the microteaching experience?" or "What did you think of the tape?" before ever viewing it. That allows us to immediately pick up on anxiety or other negative feelings and diffuse them with a little discussion before viewing the tape.
- Remind the student of the purpose of microteaching. Evidence suggests that benefits of microteaching are increased when feedback is clearly related to the goals set before microteaching (Frager, 1985).
- View the videotape carefully with the student. During the tape, we sometimes pause and ask the students what they thought of a particular part, or we may ask them to look for different positive and negative behaviors. Occasionally a student is so self-conscious that discussing the tape is difficult. In such cases, it may help to ask the student to imagine they are watching another teacher, asking questions such as "What do you like about this teacher?" or "Do you notice how enthusiastic this teacher is about the story?" Talking about the tape in third person seems to enable the students to become more objective about their performances.
- Have students select specific things they would like to improve in their teaching performance and suggest

approaches for doing so. Suppose a student wants to work on speaking more slowly and distinctly and has trouble determining how to work on that goal. We might suggest several possibilities including rehearsing part of the lesson several times in front of a mirror at a deliberately slower pace than normal, making an audio tape recording of lessons and reviewing them to check the speed, and pausing periodically in the presentation to take a breath. The student may then think of other ideas or select an action to work on the problem. At the second microteaching conference, students evaluate their own performance looking for improvements and, if necessary, revise their goals.
- End the conference positively. After goals and actions have been selected, we have students restate what they did well in their videotaped lesson. Many students seem to retain only the criticisms and have difficulty recalling the positive feedback. Having them restate it at the end of the conference leaves them with a good feeling about the experience and reinforces their positive behaviors.

Limit the Grading of Microteaching

Many instructors feel that everything of value in a course must be judged and graded. There are several reasons why grading microteaching is not appropriate:

- Microteaching is best accomplished in a risk-free environment where students can experiment with new teaching behaviors. Grading adds pressure that may make experimentation difficult.
- The emphasis should be on the process students gothrough as they plan, teach, and evaluate their own teaching and hear feedback from peers and the instructor. Grading by its very nature tends to focus on the product.
- It is almost impossible to find a fair way to grade microteaching. If you grade in a competitive way (the best five lessons get an A, etc.), you demoralize the class and penalize students with the least experience and hence the most to gain from the practice. If you grade on improvement from one tape to the next, you are being unfair to students who start off well. In fact, Frager (1985) suggests that potential benefit of microteaching increases when there are no expectations for immediate improvement.

We have found that we really don't have to assign a grade to microteaching to have students take the experience seriously. At the beginning of the course, students are told that microteaching is a requirement for the course. Their lesson plans for each lesson are turned in and evaluated as a part of the planning component. Microteaching is considered one of the pass-fail requirements, just like completing the field experience. It usually is a great relief to students that they won't receive a grade in microteaching; it allows them to concentrate on doing a good job in front of their peers and improving their teaching behaviors.

Summary

Videotaped microteaching offers the following benefits:

- Microteaching provides a safe environment for practice and refinement of important teaching skills before they are tried on real students who could be harmed by mistakes.
- The university instructor can tailor microteaching to a variety of settings and purposes. Students in a general methods course might microteach to practice formulating and sequencing appropriate questions before going out to teach an enrichment lesson; in a reading methods course, they might work on prediction to enhance comprehension just before going into an elementary classroom to read to a group of children.
- In the real classroom, students must deal with behavior problems, interruptions, and variations in student preparedness that increase the complexity of the teaching task. Microteaching simplifies the task for preservice teachers by having them teach short lessons to small groups of their peers in a controlled environment.
- Receiving constructive feedback from peers and instructors increases student confidence in their ability to be successful in the classroom.
- The complete microteaching experience offers preservice teachers an opportunity to become reflective practitioners, evaluating their own teaching to improve their skills.

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INTEGRATING TECHNOLOGY

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The Integration of Technology into Methods Courses

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The importance of technology to the education of preservice and inservice teachers has been widely recognized over the past two decades. To emphasize this importance, teacher educators have used technology as instructional tools, components of inductive and deductive lessons, and as the focus of students assignments. A variety of integration models have been proposed and investigated within different content areas. Four such integration models are discussed in this section.

White's article, "Making Social Studies Teacher Education Relevant" discusses a broad range of recommendations for the integration of technology into social studies methods courses. His article supports the fact that teachers need more training and materials to effectively integrate technology into their teaching of social studies. Some of the integration procedures mentioned are certainly worthy of much more research and extension.

The integration of technology into mathematics methods courses is discussed in Bennett's article. The course experiences include technology used by the instructor for class presentations and technology used by the students as part of their course products. The inclusion of technologies other than computers provided additional tools for effective integration.

Julie Bao's article, "ECSFE: A Model for Integrating Software into Method Courses for Preservice Teachers" suggests a very specific model for integration into methods courses. The model has many interesting components and specifically includes two steps often neglected in other integration models. In particular, the importance of a paradigm shift mentioned in step two and the individualized instruction mentioned in step four deserve further study.

Cautions regarding the integration of technology into teaching are presented through the words of four teachers involved in a technology-infused classroom. Schuttloffel's article stresses the importance of teacher belief structures if technology is to be a system change agent in our present educational system. Attitudes toward the teaching role and the integration of technology are often ignored and yet seemingly essential to the successful integration of technology.

The integration of technology into methods classes is generally accepted as essential in teacher preparation programs. While there is no established model for integration, the articles in this section stress the impact of professor, teacher, and student attitudes toward technology for effective integration. Perhaps efforts in teacher education should include a focus on the affective components as well as the cognitive goals.

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The Technology Integrated Classroom and Implications for Teacher Education: A Cautionary Story

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The integration of technology into the public educational system has been proposed as a means of transforming the curriculum and the classroom to meet the demands of an information society in the twenty-first century (Papert 1980, 1987; Kurland & Kurland, 1987; Bork, 1988; Nickerson, 1988; Barker & Tucker, 1990). The assumption that teachers are readily changed by technology to perform in new and productive ways is offered as a convenient solution to the various ailments of education. Those reconstructionist reformers who envisioned the reinvention of public education anticipate technology as their most powerful catalyst for transformation.

The discussion presented here exposes a difficulty when conflicting goals and misunderstandings exist concerning the concept of technology integration. To clarify the difficulty, three different meanings of the integration of technology into the education system are suggested: 1) technology as a tool, 2) technology as a classroom catalyst, and 3) technology as a system change agent. Some see these different meanings as a series of stages, i.e., tool leads to catalyst leads to system change. Others see them as distinct meanings with no connection.

First, there are those proponents of technology integration who view hardware and software as tools to assist in the management of classrooms; technology integration is operationalized in classrooms and schools as a sophisticated tool. Used for administrative or management purposes in the beginning, computers are sometimes added to the curriculum in computer science courses. Most often, however, the technology remains a tool, such as chalk or a textbook, used by the teacher as an additional strategy to maintain the traditional classroom processes.

Technology integration can also serve as a catalyst to transform traditional life in the classroom. Integration of technology has been proposed to expand learning productivity and possibilities, transforming life in the classroom (Bork, 1985; Pea, 1987). Recent research into the technology integrated classroom acknowledged the development of a new classroom context conducive to technology integrated learning (Salomon, Perkins, & Globerson, 1991). Technology that was catalytic intended to change life in individual classrooms; technology created a new kind of classroom culture which exemplified second stage transformation.

Third, there was the research of those visionary reformers of school structure who viewed technology as a (Papert, 1980; Nickerson, 1988) change agent for massive system reform for schooling. Papert (1987) focused attention on the fact that technology imposed upon the current educational system was ineffective in attaining the desired effect of intrinsically motivated life long learners. Structural change was not easily instigated by teachers who themselves were powerless within the traditional structures of schooling. Transformation of the structures of schooling represented a third meaning of technological integration.

Visionary reformers who believed in the power of technology generally saw the three views of transformation as linked. An evolutionary process moved the teacher from using technology as a tool to changing life in the classroom to altering the structure of schooling (Dwyer, Ringstaff, & Sandholtz, 1991; Smith, Klein, Prunty & Dwyer, 1986, Smith, Prunty, Kleine, & Dwyer, 1987; Smith, Dwyer, Prunty, & Kleine, 1988). One essential difference between these easily confused purposes of technology was the intended outcome of technology integration: was it intended as a tool, for classroom, or school change?

Teachers' Views of Integration

This study was designed to study the three stages of technology integration, their linkage, and the evolutionary progression between the stages. Direct quotations from four teachers involved in a Transformed Learning Center and the project director of the Center provide insights about their views.

Technology as a Tool

Many of the teachers' statements dealt with their view of technology as a tool. Their words describe their difficulties in spite of their resources.

> *...what I had hoped would happen, [we] would be able to better individualize and better report progress of individual students. And in order to do that we needed some sort of self-paced system, we needed a management system. It would keep track of their progress for instance...We needed some sort of automatic system like that. It was no where to be found.* (Teacher 1)

> *The only area that I have seen ... stand alone software, is in mathematics. And once again, the problem of stand alone packages is that it gets old real fast.* (Teacher 2)

> *It's the application of the technology that's important. Technology is only as good as you use it. I can do the same things these computers do with a sheet of paper and a ruler. Sometimes the computer allows you to do it faster. It allows you to grasp an image in your head.* (Teacher 3)

> *I found however that the learning was not too bad..., I don't think the programs, but the length of time that they could actually work with that was limited. About two days of that kind of work and they were antsy. They were ready to do something else.* (Teacher 2)

> *Another thing that I guess I had not counted on in terms of technology, I looked at the technology to provide the kids in grammar an alternative route, instead of teacher directed... But for a lot that's not the best way...what I failed to recognize was that I would still need to provide teacher direction for those kids whose learning style it [technology] didn't match... It doesn't release the teacher from any responsibility in terms of interacting.* (Teacher 1)

> *...what I wanted the computer for was a tool to expand and get knowledge that they couldn't retrieve somewhere else and in fact...And then what I found was, the programs that I had for social studies, it was not a program. It was a unit of this or a unit of that but none of it was put together and there was very little continuity so I could say "Here's a U. S. history unit," there wasn't such a thing that I could find.* (Teacher 4)

> *As far as curriculum itself, I think, our original intention was possibly not to go so much with the soft-ware based curriculum, but rather than to integrate appropriate software into the classroom at appropriate times. And the only person who could make that decision was the teacher because they were the ones that used it...The decision-making on the teachers was a tremendous burden for them, a tremendous burden.* (Project Director)

The remarks of the four teachers and the director of the project make it clear that the initial expectations for the first stage of transformation, the use of technology as a tool, presented problems.

Technology as a Classroom Catalyst

The teachers of the Transformed Learning Center did not describe their role of teacher as inherently changed. Such a feature is even more dramatic because two of the teachers were already committed to classroom change from their previous experiences in a middle school environment. Both teachers described their roles as not changing because their "style probably matched the project style" since they had "already changed." Technology was not seen as the catalyst.

Other teachers agreed with the theory that technology could be a catalyst for change in the classroom; however, they had difficulty accepting change. One teacher initially stated his belief that there were many creative possibilities for technology use in science education.

> *My original expectations were somewhat skeptical. Really, I thought there was some neat stuff here and hopefully I will be able to incorporate these things into the curriculum.* (Teacher 2)

However, when a student's behaviors were transformed by the use of technology, he expressed some difficulty accepting those changes.

> *It's all right to question occasionally one's objectives, but once you establish you care about the students, and that you are fairly competent in your subject matter, and that you are not out of line in what you are doing, then the students ought to shut up and do it.* (Teacher 2)

Another teacher remained unchanged in traditional beliefs and practice as a result of the project experience. There was an initial belief by Edward that stage one, technology as a tool, did have potential. His desire to be an excellent teacher, albeit by his standards, required him to participate in the project even though there was little evidence that he ever bought into or understood the magnitude of the project's goals. His participation in the project could more aptly be described as a "career move."

> *So, I think on the one hand, nothing's changed. I want to be the same type of teacher. On the other hand, I do want to have my eyes made aware of what is there that I can bring into the process to help the students.* (Teacher 4)

This teacher did recognize his own difficulty with second stage transformation. Transformed life in the classroom as it emerged was deeply conflictual with his traditional beliefs about teaching.

> *Just like I may be right in the middle of an assignment and the kid has no problem coming up and saying, "Can I go to the bathroom?" I mean I got five minutes to tell them what to do for the rest of the hour, but he has decided that's when he wants to go. And some people would consider that disrespectful. I'm probably one of them.* (Teacher 4)

The fact that this teacher considered it his job to "tell" students what to do for the next hour indicated his lack of understanding of the processes of the transformed classroom where student's were intended to make choices regarding their learning. He was the only teacher that actually questioned the usefulness of second or third stage transformation.

> *But, by the same token if we look at perhaps another area, such as discipline and that sort of thing, what administrator is going to trade one or two points of academic excellence for five or six times the disruption, the potential for behavior problems. You would have to be crazy. That's where you get sued.* (Teacher 4)

Technology as a Systems Change Agent

One teacher who described her classroom as already changed expressed disillusionment and frustration with the third level of integration. She described her original belief that the project could successfully transform the local system of education by introducing a model of the transformed classroom within their high school as a "Pollyanna attitude" and one that was unrealistic.

Another teacher who had already experienced change within his classroom described his frustration in attempting to change life in the classrooms of other teachers.

> *I mean how are you going to change someone. Changing a school system is like moving a cemetery. You are not going to get them to do it. I don't see how you can go out and over night, all of a sudden say we have all of these nice little toys now and let's try to apply them in the classroom. By the way, if you spend a little time doing it this way you will be all right.* (Teacher 3)

He discussed one of the key elements of the transformed classroom, the loss of teacher-centeredness. He recognized that teachers did not give up their powerful role within the classroom willingly.

> *A lot of teachers will not put themselves in a place of non-control. As long as their chair is a little higher than everyone else's in the classroom or as long as everyone is sitting down, it's fine. But once the kids start taking a little charge and run with it, they can't do it.* (Teacher 3)

Reflections and Recommendations

What does transformation mean for the role of a teacher? The underlying problem for teaching involves confusion about what the transformation of education means regarding the integration of technology. There are two very different understandings about the integration of technology and education: the technocrats see technology as another tool for teachers while the visionary reformers see technology as changing the nature of classrooms and schools.

These two perspectives produce a conflict between traditional teaching and schooling and transformed teaching and schooling. The conflict exists because teachers form their beliefs from their personal experiences in the classroom. Lortie (1975) states that individuals often choose to enter teaching as a career because of their comfort with the traditional role and practices of teaching. Therefore, when a teacher is introduced to the characteristics of the transformed classroom it is presumptive to say the teacher will accept the attributes of the new methodology and modify behavior accordingly. The key beliefs of traditional teaching are deeply ingrained.

The teachers involved with this project were excellent, master teachers within traditional schooling. They volunteered for the project making great professional and personal sacrifices to participate. Vast amounts of financial and technical resources were available. The point to be made is that change cannot be mandated when it involves key beliefs. Policy makers must recognize the complex process of transforming and reforming education by means of technology integration. A central player in the process of transforming education are the institutions that prepare teachers.

Colleges of education must provide preservice teachers with opportunities to reflect on what changing traditional beliefs means for life in the classroom. Professors in colleges of education must model transformed teacher beliefs within their classrooms.

Students must be provided opportunities to learn to be critical thinkers. Methods and techniques learned in professional education classes need to be critically examined. Internships and laboratory school situations that provide preservice teachers supportive environments to experiment with transformed methodology need to be created. They must learn how to initiate transformation within the traditional structure of schooling that is resistant to transformation, resistant to the teacher as leader outside the classroom.

Colleges of education also must prepare administrators to see their role in the transformation of life in the classroom and schooling as one of providing support. Administrators must reflect on the changes necessary in the community's mind to transform schooling and life in classrooms. Many in the community are more comfortable seeing their children in a classroom they recognize from their own school experiences. Many in the community press for reform through technology without understanding the importance of specifying the purpose for technology integration. And still many in the public are unwilling to invest the funds necessary to transform education.

The cautionary lesson of the Transformed Learning Center study is that there is a need, first, to clarify the purpose for using technology in the classroom. Is technology a tool or a catalyst for change? Secondly, if the purpose for using technology is to instigate a transformation of traditional teaching and schooling to a new model, teachers must be prepared to understand the fundamental change to their beliefs about teaching that must take place. Third, administrators must understand and support the evolutionary stages. Finally, colleges of education must be committed to preparing teachers who can fulfill the expectations of the transformed model of teaching and administrators who grasp the large picture of technological change.

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Making Social Studies Teacher Education Relevant: Integrating Technology into Methods Courses

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Recent graduates of social studies teacher education programs criticize their education for lack of relevance to the K-12 classroom and students. The study of social studies has long suffered from a status complex, with students stating that it is boring and irrelevant and that other disciplines receive priority in regard to materials and budget (Morrissett, et al., 1982; Shaver, Davis, and Helburn, 1979; Barr, Barth, and Shermis, 1977). As a result, technology has been integrated more slowly in social studies methods classes than in methods classes for language arts or mathematics. Because of the increased availability of appropriate technology and the inherent motivation and relevance that exists with technology use, the ideal arena for integrating technology is in social studies methods courses.

Availability, Access, Application and Attitudes

Surveys generally indicate that technology is not being widely used in the social studies (Becker, 1986; Ross, 1988). Reasons for this lack of technology use include lack of training and experience, perceived inappropriateness of software, and limited access (Ross, 1988; Northrup and Rooze, 1991; White, 1992). Ehman and Glenn (1987) state that computer use in the social studies is lacking because of poor teacher training, limited availability of software, and competition for computers between departments. Teachers have the desire to use technology in social studies classes because it is motivating, creative, interactive, and it provides variety, but teachers are frustrated because of the lack of access, training, and funding (Seidman, 1986; White, 1992).

Northrup and Rooze (1990) conducted a nationwide survey to determine whether computers were being used in the social studies. They found that 84 percent of the respondents had access to computers although only 55 percent of those with access actually used computers. Other findings indicated that secondary social studies teachers used computers less than elementary teachers even though training was desired by most teachers. A large percentage (67%) stated that their greatest need was an awareness of software available for social studies. More than fifty-five percent stated that effective techniques for using computers to develop thinking strategies were also needed.

Northrup, Barth, and Kranze (1991) and Steinberg (1988) presented a rationale for the application of technology in social studies classrooms. They suggested that American education is not working in a satisfactory manner, but that technology can be used to promote different modes of learning. Perelman (1990) stated that tutorials, simulations, and data bases in social studies are more effective and teach the same amount of material in less time than traditional forms of instruction. He concluded that computer-assisted instruction produced at least 30 percent more learning in 40 percent less time at 30 percent less cost. In addition, the use of technology could facilitate the goals of adaptive, individualized, and interactive instruction. Large group demonstrations, small cooperative group activities, and individualized activities integrating technology are particularly appropriate for social studies methods courses

(Nickerson, 1987).

Perelman (1990) reported that the ratio of computers to students is improving dramatically, from 1 to 125 in 1983-84 to 1 to 22 in 1989-90. However, the technology which is available is not being used effectively; computers are not being used systematically across the social studies curriculum. Northrup, Barth, and Kranze (1991) agreed with Perelman, stating that too little support and training is provided for teachers to successfully apply technology. They discussed the fact that technology in education has not kept pace with technology in society as a whole, with the lack of availability and application of technology denying students needed life skills.

White (1992) conducted a survey in the state of Texas to determine the availability and application of technology in secondary social studies. Sixty-nine percent felt strongly that technology facilitates social studies instruction with almost 96 percent feeling that social studies teachers needed additional training in using computers. Sixty-six percent said they never used computers although they indicated they wanted to use technology in their classrooms (White, 1988).

Schmid (1990) conducted a study to determine teacher attitudes regarding availability and preferred application of technology. A randomly chosen sample of 214 social studies teachers was asked to complete a 16-item survey. Teachers reported a lack of access and 78 percent revealed that inclusion of curricular-support materials would motivate them to use more computer software in their instruction. Thirty-one percent stated that documentation is vital and without it, the use of computers would be relegated to game playing. The preferred methods of application included one student to one computer applications and small group applications . Fifty-one percent preferred simulations as the application for social studies.

Ehman and Glenn's (1987) findings state that computers are flexible instructional tools that can assist in the development of positive attitudes, intellectual motivation, and inquiry skills in students in social studies. The use of computer applications can also assist in the preparation of students for effective participation in society. Ehman and Glenn stated that teachers require additional training to understand how technology affects instruction, learning, and classroom environments.

This is likewise true for students in social studies methods classes. These students must see relevance and at least application level technology instruction in their methods courses so that they can transfer these beliefs to their future classes.

According to Ediger (1987), student success in using computers in social studies must include meaningful and achievable activities, sequential learning, and purposeful content. Learner interest, motivation, and balance among objectives are significant considerations in planning to use technology in social studies. Higher level thinking can be facilitated by integrating technology in social studies according to Ediger. Teachers should reflect social studies goals and objectives in selecting types of software. All computer applications including simulations, data bases, and multimedia should not be integrated only for the sake of using technology, but rather as tools to support teaching goals. Preservice teachers must experience the application of technology through observation, demonstrations, and modeling for success to occur in their own teaching.

Level III multimedia, a growing trend in social studies, is defined as the integration of text, graphics, still images, and moving pictures into an interactive computer-controlled product (McCarthy, 1989). The advantages of multimedia include students being turned into proactive learners, a wealth of information becoming available for use, and skills such as critical thinking, problem solving, and researching being encouraged (McCarthy, 1989). These are essentials for methods courses.

Integration of Technology in Social Studies Methods

Preservice social studies teachers must become computer and technology literate. Any teacher education program dedicated to integrating technology must have at least one course on computer literacy. An additional course would be preferred, but is often difficult due to limited numbers of hours dedicated to education courses. The most logical place for additional educational technology is within methods courses. Objectives for integrating technology into social studies teacher education should include:

a. knowing the types of hardware and software for application in social studies curriculum and instruction
b. knowing how to evaluate hardware and software for social studies application.
c. applying packaged programs for social studies curriculum and instruction.
d. applying authoring programs for developing social studies curriculum and instructional activities.
e. developing lessons and units integrating technology.

The primary goal is for preservice social studies teachers to be able to identify, evaluate, select and apply CAI (computer assisted instruction), CMI (computer managed instruction) and authoring for all areas of the social studies. Increasing numbers of social studies education professors are integrating technology in their methods courses. Charles White (1991) has fully integrated technology with social studies methods. Simulations and database applications are demonstrated by White in the course and class objectives require an application level of technology use by all students. He requires unit plans which integrate the use of technology along with detailed software evaluations.

Increased integration of technology in social studies methods courses has also occurred at New Mexico State University at both the elementary and secondary levels. The university is at a crossroads in student awareness of educational technology with a primary goal of basic educational computer literacy before students take methods courses. The methods courses are designed to be student-centered with cooperative learning and the development and application of projects and materials as primary foci.

Technological materials are essential to the integration of technology and social studies methods classes. The College of Education at New Mexico State University had very little social studies software initially, but the establishment of a software preview center has made it possible to receive a variety of packaged materials for preview and use in methods courses. The College of Education is also a state textbook and materials adoption preview site enabling the collection of additional educational technology. Available social studies software now includes samples for K-12 applications. CAI examples include drill and practice, tutorials, simulations, and data bases. CMI examples include word processing, gradebooks, data bases, spreadsheets, telecommunication devices and presentation programs. Authoring programs for the Macintosh and DOS systems are also available. A particular focus has been the integration of multimedia and CD-ROM.

At the beginning of the semester education students in New Mexico State University are provided the opportunity to review a variety of software in centers established for tutorials, simulations, multimedia, hypercard stacks, and CD-ROM. Students rotate through centers during class time over a two week period. Other software is demonstrated through modeling by integrating cooperative learning, simulations, multimedia and the various social studies areas. The integration of science, language arts, and mathematics is also stressed during the demonstrations. Requirements for the classes also include using e-mail and other telecommunication devices, using computer simulated intentional learning environments involving blank data bases, and using technology in other projects designed for practical application. The use of technology is not limited to computer applications. Students are also provided opportunities in using video equipment for recording presentations and developing projects.

Implications and Suggestions

The availability and application of technology in social studies is improving. The effective integration of technology in social studies curriculum and instruction and teacher education requires detailed planning and thinking about non-traditional approaches to social studies. The integration of technology requires teachers to become less directive and helps to develop positive attitudes toward social studies, intellectual motivation, and inquiry skills in students. In order to increase educationally powerful uses of technology in social studies teacher education, the following issues must be addressed:

(1) Planning for technology implementation should involve colleges of education, students, teachers, administrators, parents, and the community. Requirements for planning should include:

- using the state and district technology plans, technology implementation progress reports, and curriculum frameworks as the focus,
- steps for using available technology and acquiring new technology, and
- access to technology for all social studies methods classes.

(2) Minimum and exemplary standards should be set to ensure adequate support for improving availability and application of technology. These standards should include:

- setting measurable standards toward which colleges of education, schools and districts should strive,
- establishing benchmarks to identify programs as models that are successful in acquiring and applying technology, stating that technology is expected to be applied in social studies methods and K-12,
- ensuring increased availability and application of technology be made in social studies methods and K-12,
- ensuring that preservice and inservice teachers become aware of, acquire training in, and receive access to technology,
- requiring the rewriting of social studies methods and K-12 curriculum to include increased application of new technologies,
- establishing committees including representatives from colleges of education, teachers, parents, administrators, students, and business people to plan for successful availability and application of educational technology, and
- continuing research and development on effective technology use through centers for educational technology, colleges, businesses, and schools.

(3) Training for the successful application of technology should include:

- preservice and inservice technology training for teachers (generic and subject specific),
- opportunities to receive training during school/working hours,
- opportunities to learn emerging technologies, and
- opportunities for trained teachers to teach other teachers about technology use.

(4) Technology access should be improved by providing each social studies methods class and K-12 classes with access to new technology (computers, multimedia, telecommunications) ensuring:

- the availability of at least one computer per two students appropriate to the activity, and
- the availability of a variety of social studies software for application, including emerging technologies in the classroom (multimedia, telephone access for distance databases, distance learning capabilities).

(5) Individual colleges of education, schools and districts should increase budgets for educational technology by:

- delineating a time table for acquiring new hardware and software,
- including staff development time for professors and teachers to receive training,
- paying for consultants and increasing access to exemplary programs, and
- developing partnerships between stakeholders (business, community, K-12, higher education) to improve availability, training, and application of technology.

The above recommendations are essential for improving the availability and application of technology in social studies education. Success in lasting applications of technology in education requires partnerships involving students, educators, colleges and universities, administrators, parents, business, industry, and government. School districts should collaborate with teacher education colleges to develop programs to educate teachers and administrators in technology application. Colleges of education should model technology applications in pre-service teacher education.

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ECSFE: A Model for Integrating Software into Method Courses for Preservice Teachers

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With 6,000 TV-watching hours prior to first grade and 20,000 hours before leaving high school (Skolnik and Smith, 1993), many of the students attending schools today have adopted a digital style of learning, a style that relies heavily on exciting and interactive screens for the source of information. Influenced by this learning style, printed textbooks and traditional instructional strategies alone can no longer satisfy students' needs. For today and tomorrow's youngsters, learning has to be fun, interactive, and preferably, with an exciting digital display.

In view of this learning style and a lack of preparation for matching teaching styles on the part of prospective teachers, a legion of technology educators and a host of national reports have called on schools of education to increase technology training during preservice teacher education (Drazdowski, 1993). Consequently, the teaching of perspective teachers has become a challenge to faculty who teach method courses for preservice teachers.

ECSFE (Expose, Challenge, Select, Facilitate and Evaluate) is one of the instructional strategies created by college method faculty to provide training for software integration skills. It is a five-step computer aided instructional model initiated for the math and social studies method courses at Shippensburg University in Pennsylvania. These five steps include:

1. Expose students to software applications and potentials in teacher education
2. Challenge students for a shift of paradigm toward computer integrated curricula
3. Select essential learning tasks
4. Facilitate students individually in their learning process
5. Evaluate learning progress to promote and reinforce maximum learning.

This article reports the five-step process and analyzes its applications. Following is the ECSFE model:

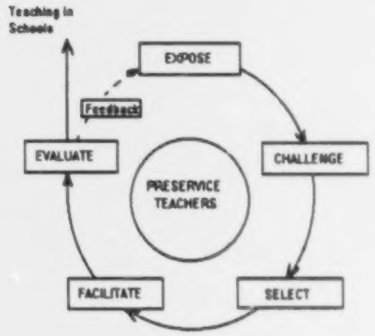

Figure 1. A Model for Integrating Software into Methods Courses for Preservice Teachers.

The above recommendations are essential for improving the availability and application of technology in social studies education. Success in lasting applications of technology in education requires partnerships involving students, educators, colleges and universities, administrators, parents, business, industry, and government. School districts should collaborate with teacher education colleges to develop programs to educate teachers and administrators in technology application. Colleges of education should model technology applications in pre-service teacher education.

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Five Steps of the Model

Step One: Expose to Software Application.

Exposing students to capacity and potentials of technology is an effective start. Though most prospective teachers have heard of courseware, laser discs and CD-ROMs, very few of them have actually seen them being used in elementary classrooms. They have a very vague idea regarding how software could be incorporated in school curricula.

Students were first introduced to a group of carefully selected courseware which enabled them to develop high order thinking skills of children. These software were chosen from a wide scope of disciplines and included "Oregon Trail", "Lewis and Clark Stayed Home", "Market Place", "Patterns", "Cavity Busters", and "Miner's Cave". Then they were introduced to the potentials of CD ROMs. They had hands-on experiences with "Grolier Electronic Encyclopedia", "World Atlas", "US Atlas" and "Time Line of History". These CD-ROMs greatly extended their perceptions about educational resources. The 250 maps in the "World Atlas" and the detailed information they could retrieve from the "U. S. Atlas" were highly motivating.

Finally they were exposed to other successful experiences of software applications in schools: 1) the Smart Classroom project in California (Slaughter, 1989), 2) the Kentucky model on educational television and professional development (Worley, 1993), and 3) the successful experience of Calvert Country School district in Maryland (Austin and Howie, 1990).

Step Two: Challenge for a Shift of Paradigm.

Exposure to exemplary software applications increased prospective teachers' sensitivity to technology application and their potentials in education, but this sensitivity was not strong enough to enable them to take risks in curriculum application. As a matter of fact, most of them still regarded courseware as an add-on component to pedagogy. These software might look exciting, but teachers could teach without them.

At this stage, students were challenged to redefine knowledge in an information age, analyze the skills that were needed to acquire and apply this knowledge, evaluate the current curriculum resources, predict the problems that their students would be solving in the next century, and synthesize the ways they would be able to facilitate their students. Naturally, all these would need higher order thinking computer skills.

Following the discussions on the nature of knowledge and, the importance of computers in an information age, a variety of materials were selected to facilitate a shift of paradigm for students toward a more computer-integrated school curricula. These prospective teachers read stories of change, discussed morals from computer-related parables, laughed at cartoons of biases, and marveled at multimedia demonstrations. Then students were challenged to vision the educational potentials of laser technology and the superhighway established by the merge of cable, telephone and computer, and define roles of teachers for the next century.

Finally they were presented a five-year technology development plan from a small and rural elementary school 17 miles from their classrooms. This plan included training programs of teachers, development of interactive video and telecommunication, networking upgrading schedule, parents involvement in technology development, and a 5-page long listing of courseware and CD ROMs currently used in the classroom teaching. Students were greatly shocked by the width and depth of computer skills that were expected of them when they would start teaching. Many commented they had never realized that computer aided instruction had become such an essential part of their professional skills. As a result of these activities, a shift of paradigm occurred. Most of these students changed from reluctant learners to active users of software.

Step Three: Select Essential Learning Tasks.

The selection of essential learning tasks for a teacher became vitally important due to the time constraints of an education program. The tasks and skills emphasized were: 1) relevant to classroom teaching, 2) skills that prospective teachers would be able to transform, and 3) skills that promoted high order thinking of children.

Relevance criterion delineated the learning of software application skills with school curriculum guidelines. Students were provided local school district and Pennsylvanian curriculum guidelines for incorporating software into teaching objectives. Transformational skills referred to learning of those strategies that would enable them to generate serious integrating activities at their future teaching positions. For example, skills of selecting software, designing computer aided teaching plans, and using Gradebook for class management belonged to this category. Preservice teachers were assigned specific tasks in relation to integrating software into teaching. For example, each of them need to be exposed to at least 10 different courseware which could be used to teach concepts/content in integrated units, or in at least 4 separate disciplines. Students were required to include technology in two of their teaching plans, write the concept/content they were teaching into learning objectives, demonstrate application of technology in their thematic unit, and analyze how and why these software could enhance learning.

Finally, the instructor selected software that would enable preservice teachers to develop their students' high order thinking skills, such as the software listed in Step One of the Model. Prospective teachers had a hands-on experience with these software and explored how they could be used to enhance the cognitive development of various students.

Step Four: Facilitate Students Individually.

When students were exposed to high-tech methods and capabilities, they were excited and generally enjoyed them. When they were required to apply software integration into teaching, however, many of them felt at loss. They were not sure where to start, and the number of software they had worked with were limited and very different. This was the time when individualized facilitation from faculty was necessary.

First, the instructor recommended some software for students to have a hands-on experience, discussing with them why and how these software could be integrated in teaching. When students had some experience of using software, the instructor required them to apply two courseware in their teaching plans according to the teaching objectives and personal preferences. The instructor used a Teaching Plan Guideline to help them organize their first teaching plan. In the Teaching Plan Guideline, the instructor asked many reflective questions to facilitate the learning process. For example, the Teaching Plan Guideline for "Lewis and Clark Stayed Home" asked the following 10 questions: 1) What concepts/content can be taught by using this courseware? 2) For which grade will it be more appropriate to teach these concepts/content? 3) How will you prepare students before using this courseware? 4) What are the procedures of using this courseware to teach? 5) How can you adapt your instruction with this software to meet the individual needs of all students? 6) How are you going to assess students' learning? 7) What are the advantages and disadvantages of using this courseware to teach compared with non-computer methods? 8) Is this advantage (if any) significant enough to justify the high cost of computer hardware and software in your school? 9) If you were going to improve this software to teach this concept/content, what would you do? and 10) What is you contingency plan if the computer or software doesn't work? After they thought through these questions carefully, put an answer to each of these questions, and tried the software with their own hands, the preservice teachers felt much more comfortable to discuss, evaluate, and use this software.

Step Five: Evaluation

Assessment and evaluation procedures need to be carefully designed to promote maximum learning. The evaluation of this instructional model was based on four major components, namely, on-going assessment; teaching plans evaluation, software application strategies, and final exit demonstrations.

Preservice teachers came to class with different experiences and computer skills and they learned at different speeds and with different learning styles. Because of this effect, the learning process of preservice teachers were carefully observed and whenever possible, individually facilitated and assessed. Teaching plans were evaluated for their creativity and efforts, as well as pedagogical and developmental appropriateness. Strategies of software selection and application were tested at the Midterm Quiz, and at the Final Test. In addition, preservice teachers had to demonstrate, either by written form or project, their preparation for computer-integrated curricula.

Discussions

Applying ECSFE model into method courses of preservice teachers is not smooth sailing. First, it runs into a time problem. All method courses have an extensive content area to cover. For example, Elementary Social Studies Methods need to cover curriculum standards, concept development, methods to teach basic disciplines such as geography and history, and expanding areas such as economy, government, law, multicultural education. Teaching children concepts and generalizations in any one of these areas may take a whole semester. Software integration and multimedia presentations are excellent, but they are very time consuming and easily distracting from teaching objectives if not focused on tasks. Instructors need to spend a lot more time preparing computer equipment and teaching plans to engage students on more important learning tasks.

Secondly, neither the University nor elementary schools at this stage can rely too much on multimedia to present and teach hundreds of basic concepts and generalizations in a classroom. Therefore, a large amount of time has to be spent to create and develop developmentally appropriate non-computer hands-on learning activities. A balance need to be kept to prepare preservice teachers with high-tech high-order thinking strategies and low-tech high order thinking strategies.

The third problem is the lack of computers to facilitate desired demonstration and hands-on sessions. Even when the equipment is there, some may quit working in the midst of teaching. Therefore, contingency plans are highly necessary when working with computers. Furthermore, both the instructor and preservice teachers need to be flexible regarding the definition of their roles. At times, the instructor has to hand-carry or move computer equipment across campus to facilitate an outstanding demonstration of students.

Despite the problems that arise in implementing this instructional model, if one looks at the achievements these strategies have brought about, all of these frustrations become worth the efforts. The achievements of preservice teachers is first demonstrated by their comfort level with computers. In the past, one of the feedbacks the university often received from cooperative teachers was that student teachers had very little experience with computers except for word processing skills. They hardly touched computers during student teaching. Now they have started using computers to provide individualized instruction, recommended software to cooperative teachers and started using "gradebook" for classroom management.

Secondly, integrating software to instruction has increased their sensitivity and positive attitude toward high-tech development and application in education. After all, this development is inevitable, and will only develop more rapidly with each passing day. Equipped with a positive attitude and necessary computer skills, the prospective teachers will be able to facilitate and lead their future students with a more exciting style of learning.

Finally, integrating software in curricula is a creative experience that encourages prospective teachers to take risks and initiations. This personal quality of teacher is of vital importance for their professional development and career if they are going to stay in the teaching profession.

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Integration of Technology in Mathematics Methods for Elementary Teachers

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The growing uses of various technology is prominent in today's society. Schools offer the uses of technology for students to be prepared for further education, careers, and functioning in society. Teacher educators will need to expose preservice teachers to the uses of a variety of technologies in order to effectively prepare them for educating today's children.

In a course, mathematics methods for elementary teachers, preservice teachers were given the opportunity to participate in a variety of experiences that exposed them to the various technology that is available for use in the classroom. These experiences included technology used by the instructor for class presentations and technology used by the students as part of their course products.

Instructor's Technological Applications

Toolbook (1989-1991) was used to create class presentations and student tutorials. Both the class presentations and tutorials are loaded on computers located in the education computer lab and are available for students' use. The presentations focused on current issues in mathematics education such as alternative assessment, hands-on problem-solving approaches to teaching, using technology in the classroom, and interdisciplinary concepts. The tutorials were more of a reflective exercise for the students of concepts discussed in class sessions. Students worked through examples, questions, and thinking processes about more content-oriented teaching processes such as teaching regrouping in subtraction, two-digit division, finding area, and division of fractions.

Video tapes presenting informative topics about mathematics and education were shown and used in class lessons and lab periods. Some of these video presentations included demonstrated uses of manipulatives, the National Council of Teachers of Mathematics' (NCTM) video *Mathematics: Making the Connection* (1991), and actual lessons taught to demonstrate NCTM's *Teaching Standards* (1991) produced by the Center for Mathematics and Science Teaching at Texas A&M University. Also, students' teaching episodes were video taped during their teaching experiences in the public schools. This was set up on a "buddy" basis in which each student has a buddy or even buddies (depending on the total number of students) to video tape their lesson. Reflective sessions after the experiences were conducted with each student. The video tape was viewed and discussed by both the instructor and students. Students collected these video tapes to be used as part of their portfolios.

Cooperative groups were audio-taped during presentation/discussion sessions on current issues. Three days out of the semester were designated as presentation/discussion days. Students prepared a short presentation on a current issue they had researched and shared this information with their cooperative group. These tapes were used by the students for reflection of the topics discussed. These audio tapes were also used for additional evaluation of the students' presentations.

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Students' Technological Applications

Some of the course products required of the preservice teachers in the course involved the use of or promotion of technology. The implementation of these activities followed suggestions outlined by the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards* (1989) and the *Teaching Standards* (1991). NCTM's *Curriculum and Evaluation Standards* (1989, p. 8) suggested that appropriate calculators be available to students, computers should be available for demonstration, individual, and group work, and students should learn to use computers as tools in investigations and solving problems. Standard 4 of the NCTM *Teaching Standards* (1989,p. 52) describes tools for enhancing discourse in which teachers are encouraged to promote and accept the use of various technology such as computers and calculators.

Preservice teachers gained experiences with activities that use calculators as learning tools. During the hands-on portion of the class, students used calculators in learning activities that were demonstrated for use in the development of mathematical concepts for elementary students. They used calculators in the lessons they taught when working with elementary students in the public schools. Learning centers which include the use of calculators were constructed and used in the classrooms and for future use in their own classroom.

Access to computers and computer software was offered for students' review and evaluation for application. The software that was shared with the group included word processors, databases, desktop publishing, and calendar programs along with educational software that could be used with elementary children in the classroom.

Preservice teachers were introduced to computer networking and the various electronic communications available. This included e-mail, BBSs, the college system, and on-line services such as *America OnLine* (1992). Preservice teachers have computer assistance with the college system, which includes access to library information and e-mail, offered in the various computer labs across the campus. Plans for the next semester include student-instructor communication through e-mail during the course.

Multimedia presentations were used and demonstrated in the course. The preservice teachers had access to a computer lab in which they spent outside class time creating presentations and/or tutorials as part of the course products. Some preservice teachers used these multimedia creations in their lessons they taught in the public schools and plan to use them in student teaching and future teaching.

Conclusion

The integration of technology in teacher education courses is slowly beginning to progress. This integration will become more apparent as teacher educators begin to see the value of the addition of technology in class sessions. Some teacher educators find it difficult to keep up with the current technological practices that can be very beneficial to classroom teachers. One avenue that teacher educators can pursue is to maintain close relations with public schools and the technology that is currently being used by classroom teachers. These "practical applications" can be implemented by teacher educators as part of class sessions, hands-on activities, and students' course products. An additional avenue for teacher educators is to participate in or request staff development in the area of specific applications of new technology.

Technology can be an exciting resource, teaching tool, and communication tool. Instructional practices stand to benefit from the options that various technology offers for education. As classroom teachers begin to integrate technology, teacher educators need to think about restructuring teacher education courses to address this integration.

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INSERVICE & GRADUATE EDUCATION

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The articles in this section describe a broad range of ways technology is being used in inservice and graduate programs. The work presented in these articles brings us closer to an educational environment where administrators and faculty members will no longer be asking *if* they should be incorporating technology into their teacher education programs. Instead they will be asking *how* they can best accomplish this task.

However, there are pitfalls inherent in promoting widespread technology use too quickly without adequately contemplating the effects the technology will have on society in general and on education. Today, educators and their students have access to more technology to access more information and solve more complex problems than at any time in history. And even more powerful tools are coming. But new technologies alone will not provide easy solutions to societal or educational problems. The challenge to educators is to thoughtfully and often painstakingly develop new instructional models that can best take advantage of these developing technologies. The articles in this section (and in the entire Annual) are meeting this educational challenge by describing different ways that technology can be used to promote excellence in teacher education.

Kearsley and Lynch focus on a program of technology rich graduate courses they use to adequately prepare future leaders in educational technology. The program provides firsthand experience with technology, courses on policy, management and leadership – not just instructional technology itself. Within the program, there is an emphasis on human interaction. Students take courses from faculty members who use technology in their classroom but who are not educational technologists. This helps students think about technology use from the point of view of their colleagues and broadens their perspective. Collaboration via computer networks, where students interact with the course instructors and their classmates, is also an integral part of the program.

Jones and Wall summarize a research study which involved integrating computer skills into an educational research course. The course required that students develop a research proposal and use word processing, electronic mail, CD-ROM-based reference materials, and telecommunications as part of the process. Attitudes toward technology uses and educational research were measured along with student performance.

In a similar study, Poage, Munson, Ramsay, Conners, and Evavold outline an approach for effectively integrating technology into instruction using a course in educational research and statistics. A second goal of the project was to motivate faculty to model use of technology to inservice and preservice education students. Six HyperCard-based lessons were developed and used in the course in addition to traditional textbooks. Both quantitative and qualitative data were collected concerning student attitudes about both computer technology and research and statistics.

Bright, Kennelly, and Harvey discuss a summer institute that prepared high school, college, and university faculty

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members to lead workshops which would help AP Calculus teachers learn to use graphing calculators.

Casey presents a thoughtful argument for keeping computer programming as a main component in computer and technology education. This discussion of programming as a natural and effective way to teach problem solving and higher-order thinking skills provides a review of the historical debate which exists in this area.

In his article, Liao examines the effects of different types of computers on student performance and attitudes toward computers in the educational environment. In the study, he compares the use of Macintosh and IBM personal computers and examines inservice teachers' knowledge of computer literacy, conceptions and misconceptions of computing concepts, and attitudes toward computers.

Interactive multimedia is the topic for Breegle's article on a qualitative study which used Linkway Live! as a planning tool for public school teachers, home school parents, and Sunday school teachers. Project participants were interested in learning how to integrate technology into their curricula and were able to identify the characteristics of powerful learning experiences and to determine strategies for overcoming barriers.

Multimedia is also the subject of Olivier and Buckley's paper. They focus on a graduate program designed to provide an educational experience which uses the most effective media with which to convey specific forms of information and harnesses the pedagogical power of each of these media. The authors describe what they call a "blended approach" to technology and teacher education, which effectively combines theoretical and practical coursework.

Two papers deal with the use of audio technology. Knapczyk, Rodes, Marche', and Chapman present a low-cost option for providing inservice coursework through distance education technology. They recommend combining available inexpensive technologies such as speaker phones and fax machines, two consistently reliable forms of technology which are often overlooked, with other more advanced computer systems. Hessmiller discusses a research study which compares the effectiveness of audio and computer conferencing in the delivery of special education training to educators in correctional facilities. This article underscores the power of technology to provide educational opportunities to isolated rural settings which have traditionally had limited access to instructional resource centers and materials.

Unikel and Handler describe their efforts in helping develop a district-wide technology plan. With a behind-the-scenes approach, the authors trace three years of experience from formation of a Technology Task Force, through staff development programs, toward final commitment and implementation. This article provides an in-depth view of a successful school/university collaboration with insights into the components and personalities that make up the entire school improvement process. It will be of interest to educators who face similar challenges.

Lee presents two articles which deal with training models for inservice teachers. The first paper outlines a model with a developmental view of providing computer education to inservice teachers who are novice computer users. Instructional content is covered in a five-stage process which emphasizes a risk free environment for exploration and experimentation. Lee's second article describes a hypermedia model for converting teachers from novice hypermedia users to independent hypermedia developers. The goal of the five stage model is to empower inservice teachers to independently implement a hypermedia package for instruction.

The articles in this section provide us with a view of how technology is being used in graduate and inservice programs today. They add to the growing body of knowledge in the field, from designing computer literacy courses to developing hypermedia programs for statistics and educational research, from using audiographic technologies to implementing district-wide technology plans. These articles not only show us where technology use is today, they also plot the course of where technology use is going in the future.

Preparing Educational Technology Leaders: A Formula That Works

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The question of how to best prepare individuals to assume leadership roles in the field of education is a much discussed issue (e.g., Hallinger, Leithwood & Murphy, 1993; Smyth, 1990). We are primarily interested in this question from the perspective of leadership in the domain of educational technology (Kearsley & Lynch, 1994). It is our belief that one of the major reasons that educational technology has been used poorly in many school systems and organizations is the lack of good leadership on the part of administrators and teachers. In general, Schools of Education have failed to provide the appropriate training needed by educators to put technology to good use.

The Educational Technology Leadership Program

For the past five years, the Educational Technology Leadership (ETL) program at the George Washington University has used a combination of instructional television (ITV) and computer mediated communication (CMC) to deliver its graduate courses. This means that all students have extensive first-hand experience learning via technology (as well as distance education) by the time they have completed their MA degree. Furthermore, the evaluation in most of our courses is project-oriented; students must apply what they are learning in a course to a real teaching/learning situation in their school or organization (almost all of our students have full-time jobs in education). In many cases, we ask students to make videotaped project reports, giving them further hands-on experience with technology.

An even more important outcome derives from the use of CMC — students interact extensively (at least 1 hour per week) with the course instructors and their classmates using a bulletin board system (BBS). This interaction takes place primarily in the context of completing online assignments in which students must discuss and debate critical issues in the field of educational technology. In many cases, we ask students to work in pairs or small groups on assignments or projects. However, there is also a great deal of informal interaction among students with common interests or focused on shared problems. Students who complete our program have a lot of experience working with their colleagues via electronic networks and are likely to continue to do so for the rest of their careers.

Another vital element of our program is involvement of other faculty in the School of Education and other departments who are not themselves experts in educational technology but willing to use technology to teach courses in their area of expertise. Our program includes courses on leadership, policy, research methods, software design, and telecommunications (see Table 1) that are taught by faculty members who are not educational technologists. This is important for a number of reasons. First, it allows us to offer courses on topics that are critical to an understanding of leadership that are beyond the realm of educational technology. Secondly, this ensures that our students have contact with faculty who are not technology "insiders" but just "users" with a relatively neutral perspective on its use. We believe this helps students to think about technology use

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from the point of view of their own colleagues.

Critical Components

In our televised classes, we try to address a number of critical components of leadership including: critical analysis, problem-solving, decision-making, strategic planning, vision, team-building, and so on. We do this by presenting divergent points of view on topics, presenting issues and asking students to think through the implications, presenting options and asking students to decide which choices are best, presenting actions/tasks and asking students to prioritize, presenting problems and asking students to invent solutions, and presenting strategies and asking students to develop implementation plans. These are skills that we try to emphasize across all our courses using a number of different means.

We feature many guests in the classes who are experts in the field of educational technology and the specific topics covered in the courses. This means that students have considerable exposure to actual leaders as role models, not to mention the most up-to-date and authorative information available. In many cases, guests talk about technology-based projects they are involved in, providing students with case studies and examples. We also show many videotape segments of technology-based projects to provide further examples. We believe that it is important for students to be exposed to many examples in a course so they are aware of how technology is being applied at schools and companies in the U.S. and globally.

We often do software demonstrations and ask students to critique the programs in terms of design, development or effectiveness issues. Students can call in during the televised class and make their comments immediately or they can post their comments as messages on the BBS after the class is over. This allows for more reflective analysis as well as a full discussion involving all students in the class. Sometimes we do the reverse: ask students to generate questions or issues they want the instructor to examine in detail in an upcoming class — in this case, online discussion precedes the demonstrations or interviews.

One over-riding concern is that we adhere to adult learning principles in the design and delivery of all our courses. Almost all assignments and projects require that students interpret and apply course content to their own work and personal circumstances. We encourage students to provide examples and wisdom from their own experience as educators. We expect students to be self-motivated and responsible for managing their own learning progress. Finally, we try to provide as many opportunities for teamwork and peer evaluation as possible (which also serve an important socialization role).

Outcomes

In general, students rate the courses and the program very highly. At the end of every course, we ask students to provide a critique. Here are some sample responses from one course:

Student #1

I found this course to be interesting, very informative and exciting. Both instructors had well prepared and organized lessons. I thoroughly enjoyed the structure and presentation of each class format. Having an outline of each class prior to the start of class was very helpful. I also found the intergration of videos with interviews, lectures, and discussions to add more variety to the class format. The humor and metaphoric skits were especially enjoyable. I hope this will be a feature included in future courses. All of the above, kept the class moving and held my attention, which kept me motivated during times when I was exhausted from a long hard day at work.

Student #2

Well, here is my two cents on the good, the bad and the ugly. I enjoyed the class very much. Distance learning is making a masters degree possible for me. I could not otherwise be going to school. I enjoyed the guests and felt

Table 1
ETL Program Curriculum

Required Courses:
Managing Computer Applications
Educational Hardware Systems
Applying Educational Media
Computers in Education & Human Development
Design and Implementation of Educational Software
Power, Leadership and Education
Policy-Making for Public Education
Quantitative Methods I: Survey Measurements & Research
Quantitative Methods II: Research Procedures
Electives:
Media Services Management
Introduction to Interactive Multimedia
Telecommunications and Education
Developing Interactive Multimedia

that they add a dimension to the class that we could not get in a traditional classroom. I have never taken a traditional class with a guest speaker almost weekly. I find the application videos interesting to watch and useful for sharing with my colleagues to spark interest. Partnering for assignments was interesting, and it did have us communicate more with our classmates, but I found it a little stressful having someone else depending on me for part of their assignment.

Student #3

I also really enjoyed this course ... my first in the distance learning format. The highlight for me were the video tapes which clearly showed techniques for using multimedia with children. Although most of the tapes seemed specifically designed to show the actual multimedia product themselves, I found that the teaching styles that were demonstrated along with them to be even more interesting. They was a continual emphasis on the role of the teacher as the facilitator of learning rather than someone who simply gives facts and answers. I also really enjoyed the format of the lessons.

Student #4

The two courses I've taken have been excellent. I am very excited about the prospects of distance education and graduate study... I think as the program matures it will just get better. It is a very time efficient way to pursue a graduate degree and you all are doing a great job. Your class preparation is obvious and instructor subject knowledge is outstanding. The guests are informative and the tape demos are good. I would like to see a little more topic specific information put out during the classes. Humor goes a long way in eliminating topic dryness. The BBS assignments were good and the instructor comments were prompt and to the point, amazing given the number of students in the class.

Student #5

I was very pleased with the class, as usual. There is no way I could have possibly taken graduate work in educational technology without this distance learning. The one criticism I have of most of the ed. tech. classes is that they are dry and lack humor. Bill and Greg have outdone themselves with their efforts to include this important aspect. I found the flexibility of the project requirements wonderful. I hate doing projects that I can not use in "real life." I like the interaction on the bbs. I feel pairing us in different groups of two for different assignments is great. I hate to sound like such a brown nose, but I even thought the video clips were good.

Student #6

In general, I found this class interesting, full of information, and a real challenge for me. At first, considering that this was my first long distance learning class, I felt lost. Using the BBS was a great way to converse with the class once I learned how to navigate through the system.Using the BBS for assignments and discussions proved to be one of the most valuable parts of the class......talk about hands-on...interactive learning !! It opened up a new form of interactive multimedia while allowing me to express my ideas and share opinions with the classmates and instructors. I've learned alot !! I am anxiously looking forward to the Fall class.

Student #7

I thought it was a great course . I enjoyed it right from the start.I never heard of multimedia before taking this course.Everything I know about multimedia I learned in this course. I think that the use of television and the bbs is terrific.I can come home after a hard days work and watch the class in the comfort and convienience of my own home. I don't have to waste my valuable time travelling to some distant location to be at a class. If my employer wants me to work late or if I have a social obligation then I do not lose out because I have the class recorded on video tape.If there is something I do not understand in the lecture then I can reverse my tape and play it over again and no instructor is going to jump on me for not listening wellenough the first time. The bbs gives me a chance to make contact with other students from other parts of the country and to work with them on assignments and learn from them.

Student #8

When I first contemplated the course, with my travel schedule limiting my participation in school programs requring classrooomattendance, I was excited about the prospect of distance learning.The feature of catching up after the fact via video tapes also encouraged my decision. Mechanically, the BBS and the ease of communication by phone.fax. etc. from all over the world has allowed me the feeling of staying connected with the class. Although I have not used the BBS much in an E-mail mode, I have enjoyed reading the messages, and have learned from many of them, and rate this facility highly. As a general statement, the televised classes were excellent, with the examples and interview framework interesting and informative, and accomplished well the purpose of introducing us to IMM and its current state. The project assignment has greatly improved my computer skills, has been hard work but fun, and has stimulated a strong desire to continue my education in educational technology. Overall, for me, the course accomplished its purpose, and I give the highest ratings to the tolerance of the instructors with regard to due dates, and my lack of computer skills in conveying assignments, etc. This created an atmosphere of caring and acceptance that served well as motivation to hang in there. I would recommend this distance learning method to anyone who has similar time constraints and I intend to continue taking courses this way. Thank you!

Many of the students report that they become very comfortable with technology after completing a few courses, despite little experience (and sometimes considerable anxiety) when they start the program. Furthermore, many of them move into leadership positions (e.g., technology coordinators, project managers, school administrators) during the program as a result of the first-hand experience and knowledge acquired. We are in the process of measuring job performance impact in detail and will discuss these findings in our presentation. Table 2 lists the type of questions we are asking in our impact study.

Table 2
ETL Program Impact Questions

- Can you describe specific skills that you have acquired due to participation in the ETL program?
- Has your ability to initiate technology-based projects improved as a consequence of being in this program?
- Have you received any special recognition for your technology expertise since you started this program?
- Do other people consult you more often about technology since you have been in this program?
- Has your participation in this program improved your job or career opportunities?
- Do you feel more confident or competent in your current job as a result of skills and knowledge you have acquired in this program?
- Have your views about technology changed significantly since you have been in this program?

Conclusions

We believe that our program is a good formula for preparing future leaders in educational technology. First, it provides a great deal of first-hand experience with technology over a period of 2-3 years so students understand it thoroughly. Secondly, the curriculum includes courses on policy, management and leadership, not just instructional technology itself. Thirdly, the emphasis on human interaction and collaboration via CMC creates a disposition to teamwork which is an essential characteristic of good leaders. Finally, it involves faculty who are not educational technologists and provides a broader perspective on the use of technology by educators.

Based upon the success of our program, we conclude that extensive, first-hand experience using technology is a critical component of preparing educational technology leaders. Programs that simply discuss/describe technology, or provide a few isolated hands-on opportunities, are not likely to adequately prepare educators to adopt leadership positions with respect to technology. Until this fact is accepted, we are likely to suffer a deficit of good leadership in the domain of educational technology. We hope our ETL program will serve as a model and inspire other Schools of Education and school systems to pay more attention to the leadership aspects of educational technology.

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Integrating Computer Skills Into Educational Research Courses

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This report examines the integration of relevant computer skills into an introductory educational research methods course. The course was a required course for all master's degree students in elementary, secondary, and early childhood education at Towson State University. This exploratory study was conducted during a seven-week summer session in 1992. The course required that students develop a research proposal for a study to be conducted as a part of their master's degree requirements. Skills selected for inclusion in the course were ones that were deemed relevant and useful in the process of proposal development. These included use of a word processor, use of electronic mail, access and use of CD-ROM-based references, use of a small-scale statistical package, and an introduction to a statewide computer network for educators. Attitudes toward educational research and computer technology were examined at the beginning, mid-point and at the end of the course. Those attitudes were examined in relation to student performance measures.

Background

A variety of approaches have been tried in teaching both computer literacy skills as well as research methodology. With computer skills one may use either a separate computer course or curriculum or one may attempt to integrate computer skills into the existing curriculum (Lockard and Wesley,1990). The integration approach has the advantages of providing an existing context in which computer skills may be applied. However, integration of computer skills also has the disadvantages of limitations in terms of time allocation, focus of students' attention, and negative interactions with the course content. Previous studies by Jones and Wall (1990) have also found there to be a significant amount of anxiety among students regarding the acquisition of computer skills. Age and gender differences in computer attitudes were found in several studies.

Few have systematically investigated the integration of computer skills into educational research courses. Lane and Wells (1990) reported upon the use of computer assisted instruction modules in areas of statistics and research methods. Stephenson (1990) reported on the use of statistical software in research methods courses for library science students. O'Quinn (1990) reported on the use of computer software in a research methods course for psychology students. Fons (1989) reported on the use of a software evaluation tool used in order to determine the manner in which computer software could be integrated into existing courses. Nicklin (1992) reported on the integration of general computer skills within a College of Education.

However, none of those studies examined how the computer skills and the students' attitudes might be related to course performance. In this study, we were interested in selecting appropriate and useful computer resources for an introductory educational research course. We examined to what extent the inclusion of those resources would correlate with measures of course satisfaction and comfort in using those resources.

There are many reports on the use of software for

Table 1
Data Collection Timetable

Pre-Course	Mid Course	Post-Course
CA Score	CA Score	CA Score
ER Score	ER Score	ER Score
	Test 1	Test 2
		Proposal
		Total Points

Note: CA = Computer Attitude Scale
ER = Educational Research Attitude Scale
Proposal = Score on required research proposal
Total points = accumulated points for all tests and assignments.

specific purposes in research courses, and it appears that integration of computer skills into existing courses is proceeding at a rapid pace. The purpose of this study was to examine computer skills integration in relation to attitudes and performance in a research methods course.

Methodology

Hypotheses that were investigated in this report included:

- There will be no significant difference in pre and post course computer attitudes. $p.<.05$
- There will be no significant difference in pre and post course educational research attitudes. $p. <.05$
- There will be no significant relationship among pre, mid and post computer attitudes and performance test 1. $p. <.05$
- There will be no significant relationship among pre, mid and post educational research attitudes and scores on performance test 1. $p. <.05$
- There will be no significant relationship among pre, mid and post computer attitudes and scores on performance test 2. $p. <.05$
- There will be no significant relationship among pre, mid and post educational research attitudes and scores on performance test 2. $p. <.05$
- There will be no significant relationship among pre, mid and post computer attitudes and total points earned in the course. $p. <.05$.
- There will be no significant relationship among pre, mid and post educational research attitudes and total points earned in the course. $p.<.05$
- There will be no significant relationship among pre, mid and post computer attitudes and points earned on the course research proposal. $p.<.05$
- There will be no significant relationship among pre, mid and post educational research attitudes and points earned on the course research proposal. $p.<.05$

Another area investigated included the internal consistency of the attitude instruments used. A preliminary factor analysis of the items in all the measures was also conducted.

Subjects

Subjects of this study were 31 graduate students in teacher education at Towson State University. Students were enrolled in two sections of the course "Research in Education" which were offered in the summer, 1992. All students were experienced teachers at the elementary, middle, or secondary levels. All students were required to take the research class and most were required to carry out a research study proposal developed in the courses.

Data and Data Analysis

Data were collected during the courses and are shown in Table 1. The computer attitude scale was a 19 item likert-type adjective checklist which asked students to respond to items in categories of word processing, CD-ROM data base searching and electronic mail. The educational research scale was a 19 item likert-type adjective checklist in which students responded to positive and negative items related to educational research. The SPSS subprogram, "reliability" was used to find coefficients of reliability for each administration of the instruments. Cronbach's Alpha was employed. Resulting coefficients ranged in value from .91 to .97 for both measures.

Results

SPSS's MANOVA repeated measures model found significant differences among means of the three different administrations for the computer attitude measures. Results indicated a positive shift in computer and educational research attitudes from the beginning to the end of the course. Table 2 summarizes scores on the computer and educational research attitude scales.

Table 3 summarizes the results testing hypotheses 3 through 9. The hypotheses concerning relationships among the measures collected were tested with the Pearson product moment correlation procedure. Inspection of the table reveals only 5 statistically significant correlation coefficients.

Discussion

This preliminary study indicated a positive shift in attitudes toward computer technology skills selected for inclusion in the course. A similar shift in positive attitudes toward educational research also occurred. It is interesting to note that there were significant positive correlations between test one and test two, scores on the research proposal and test 1, and pre course computer attitudes and test 1. Also, a significant relationship between computer attitudes at the mid-point of the course and test 2 was found. However, given the 18 correlations between computer attitudes, educational research attitudes and achievement, only three of the 18 were significant.

There does appear to be support for the strategy of selecting appropriate and useful computer resources for

Table 2
Computer and Educational Research Attitude Measures and scale reliability (alpha)

	Educational Research			Computer Attitudes		
	Mean	S.D.	Alpha	Mean	S.D.	Alpha
Pre	2.9	.49	.91	1.9	.63	.91
Mid	3.0	.5	.92	3.0	.65	.94
Post	3.1	.64	.95	3.3	.74	.97

inclusion in such courses. Based upon the results of this study, we have questioned if those computer-based resources need to be introduced earlier in the graduate programs. We also wonder if introduction and application of those computer resources in a greater variety of courses would increase the benefits of those resources to graduate students.

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Table 3
Correlation Coefficients

	Hours	Test 1	Test 2	Proposal	Mean	SD
Test 1	-.18				44.8	2.7
Test 2	-.07	.56**			44.4	3.5
Proposal	.07	.48*	.34		93.1	4.8
Pre ca	-.22	.39*	.35	.01	1.9	.6
Mid ca	-.13	.29	.66**	.16	3.0	.7
Post ca	.02	.21	.43*	.09	3.3	.7
Pre er	-.29	23	.19	-.09	2.9	.5
Mid er	-.03	.02	.08	-.22	3.0	.5
Post er	.08	.00	.18	-.05	3.1	.6

Note: *Significant p.<.05 **Significant p.<.01
Hours.=Number of credit hours completed in graduate program.

HyperCard Based Courseware: A Tool for Facilitating Learning in Graduate Education

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At Gonzaga University we continue to struggle with two primary technological concerns. First, how to effectively integrate technology into instruction, and second, how to motivate faculty to model the use of technology to inservice and preservice education students. The focus of this pilot study was to investigate the effects of integrating HyperCard-based courseware into a graduate course in educational research and statistics.

Project Description

During the summer session of 1993 a large number of extension center graduate students came to the campus of Gonzaga University to complete two courses toward their master's degree. During this time all students completed a four semester hour course in research and statistics. This course was conducted in a very intense format where students received instruction over an eight hour period, three days a week, for four weeks.

Historically, this course has invoked a great deal of anxiety in the students, due primarily to the timeline of instruction and the nature of the course content. In addition, the faculty often feel stressed in the delivery of this course because time is limited, groups are large, and time is not available to individualize the learning process. Given these factors, a team of four faculty members decided to integrate a series of HyperCard-based course materials throughout four sections of a research and statistics course.

As the planning began for this project, significant discussion focused on the theoretical framework that would be used to both design and implement the HyperCard materials. A decision was made to combine Ausubel's (1963, 1977) model of expository teaching with Bruner's (1960, 1966) model of guided discovery teaching. In practice, the computer materials would be used to deliver instruction that was more sequential and directive, yet still requiring interaction. The instructor's time during class would be used in more of a guided discovery approach. Thus, the more traditional teacher-centered lecture format that had previously occurred in this class was eliminated.

Project Timeline

Figure 1 illustrates the timeline for the planning, development, implementation, and follow-up used for this project. During the four weeks students were on campus, class time was devoted to discussion, the instructor generated questioning, and a two-hour time block was reserved each day in the computer lab for each class. During the computer lab time students were primarily asked to work through the HyperCard courseware, however additional computer applications were also available, (i.e., remote access to the library card catalog and online databases, software to facilitate statistical analysis, and word processing for the drafting of a research proposal.)

After careful consideration, six HyperCard-based "lessons" were prepared addressing the major units taught in a research and statistics course. The titles of the HyperCard stacks were:

- Educational Research: An Introduction to the Process
- Educational Research: Ethical Practices

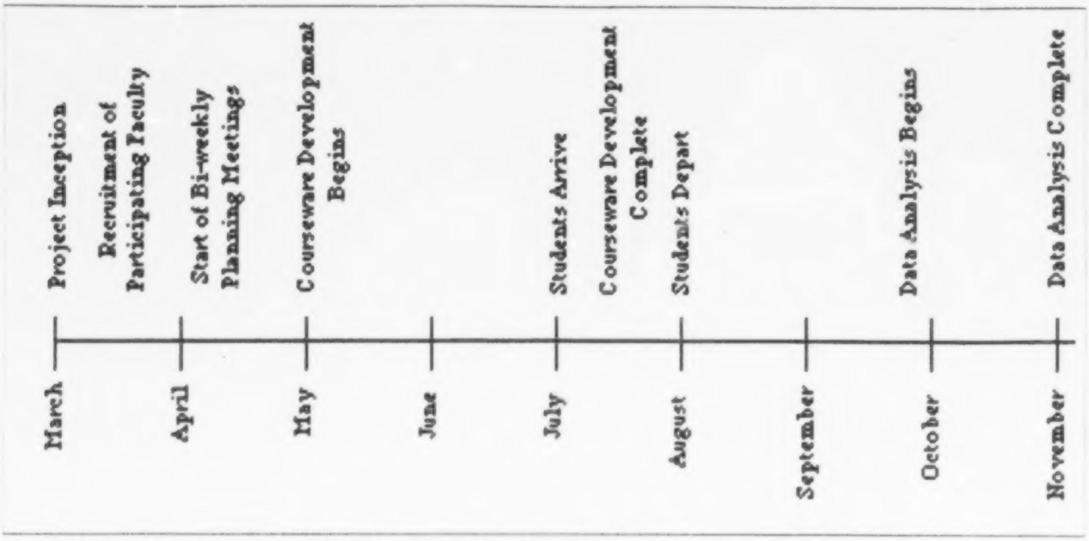

Figure 1. Timeline for Development and Implementation of HyperCard-based Courseware into the Research and Statistics Course.

- Educational Research: Fundamentals of Statistics
- Quantitative Educational Research: Applied Statistical Analysis
- Educational Research: Qualitative Analysis
- Educational Research: Evaluating and Consuming Educational Research

Each of the HyperCard lessons presented fundamental concepts related to the major topic. For example, in the lesson on ethical practices, concepts such as participant risk, confidentiality, informed consent, deception, and debriefing were introduced. The HyperCard lessons also allowed a great deal of interactivity, either by requiring a simple answer to a question, or more often, by asking the student to compose a response that would be taken to class and discussed in greater depth. In the Ethical Practices lesson, students were given a choice of six scenarios describing various research studies. The students were to read these scenarios and analyze how well each study addressed participant risk, confidentiality, informed consent, deception, and debriefing. The analysis was then composed within a HyperCard stack and printed.

The content of each of the stacks was a synthesis of several references, however students did have a traditional text for the class. In fact two different textbooks were used across the four sections (Borg and Gall, 1989, and Gay, 1992). It was intended that the HyperCard lesson be somewhat "text independent" so that future instructors would still feel free to use their choice of textbooks.

Research Methods

The primary research questions addressed by this study are:

- How does the integration of computer-based courseware affect student perceptions and feelings about research and statistics
- How does the integration of computer-based courseware affect student perceptions of their learning in a research and statistics course?
- Does the use of computer-based courseware in a research and statistics course change student feelings about using the computer?

In order to collect a broad range of data, both quantitative and qualitative data were collected throughout the month-long class. Quantifiable data concerning student attitudes (anxiety, interest, confidence, and usefulness) about computers, and research and statistics were collected using the Computer Attitude Scale (Loyd and Gressard, 1984) and a modified version of the Computer Attitude Scale, reworded to reflect attitudes about research and statistics. These instruments were used during the first and last class sessions.

At the beginning and end of the four weeks of class, students were asked to reflect on the following questions in HyperCard-based journals:

- Please take a moment to reflect on how your research and statistics class is going. Is it what you expected? Is it going along better, worse, or about the same as you thought it might?
- Please take a moment to reflect on the impact of the computer-based courseware on your research and statistics experience. What impact do you feel the computer-based courseware is having on your learning of research and statistics?
- Please take a moment to reflect on the structure of the research and statistics course. How do you feel about

the instructional model being used? What impact do you think this approach to research and statistics is having on your comfort level and your learning in the class?

The journals also included eight questions that asked the students to indicate their current attitudes toward research and statistics and use of computers. Responses to these questions were indicated on a five-point Likert scale, and mirrored the Computer Attitude Scale (i.e., feelings about anxiety, interest, confidence, and perceived usefulness.)

Qualitative Results

An analysis of the journal entries presented a wide range of reactions. Some students communicated their anxieties and frustrations with the subject-matter, as well as problems with the technology. However, most students expressed their interest with the courseware and their appreciation with the manner in which the materials were individualized. The following excerpts were typical responses made by students throughout the month-long course:

Journal Entry #1

Question 1. Class Progression

So far I am about where I had expected that I would be with reguards to research. I am very happy with the research and statistics course because the assignments are so practical and have helped clarify in my own mind where I am going with my research and how I am going to get there.

Question 2. Impact of Computer-based Courseware

I believe that the computer-based courseware is going to allow me to become far more fluent in research terminology. I believe that it will accelerate my learning and will give me greater confidence in two areas - computer work and research and statistics.

Question 3. Structure of Course

Using the approach of learning at your own pace in class is fundamental to the principle of life-long learning. To me, personally, I feel at ease. I feel more ownership in the work that I am doing. I believe that this approach allows me to feel comfortable and I believe that I will enjoy what I learn in this class.

Journal Entry #2

Question 1. Class Progression

I am very happy with the way my research course is going. No, this is not what I expected. I thought when I came down to Gonzaga that the research and statistics course would be a lecture course where assignments were to be done entirely out of class. It is going along better that I had anticipated.

Question 2. Impact of Computer-based Courseware

I believe that computer-based courseware will increase the rate at which I learn the basic content of the course. It will also increase my typing rate. I believe that I will learn more about what the computer can do so I can do a better job of presenting my research.

Question 3. Structure of Course

I agree with the comment that I had made yesterday, that is, I appreciate the model used with our class. Individualized instruction keeps my dignity intact. Because there is such a wide gap with regards to experience in our group as well as interests it is important that we all feel good about what we are doing. I feel very comfortable in the class. By the way I am adjusting to "THE MAC".

Journal Entry #3

Question 1. Class Progression

Today's class was wonderful. I really enjoyed going through the statistics notes. I actually enjoy graphing. When I read the textbook, I was worried about the complexity of the terminology. However, as I went through the stacks, previous knowledge I attained from previous courses came back to me. Being able to visualize terms and make the associations from a set of data to a graph was great.

Question 2. Impact of Computer-based Courseware

My stance has not changed, and I would like to learn more on how I can apply the same idea in my classroom. Perhaps, it is possible for me to book the network lab at our school for two weeks and go through notes and concepts that I would like to touch upon in a French class.

Journal Entry #6

Question 1. Class Progression

Stacks four and five were very interesting. In particular, I enjoyed the set up of stack four. Having three levels gave me time to reflect before going on to the next level. I had this terrible urge to print all, and I do mean ALL, the information listed. Perhaps I need a bit more interaction with the computer as I go along. Actually, I believe things are going better than I had thought because the math is clicking in now. In fact, I am beginning to understand better how to put word sentences into mathematical sentences.

Question 2. Impact of Computer-based Courseware

I continue to feel as I have since the beginning, that is, computer-based courseware is helping me to make sense of the textbook.

Question 3. Structure of Course

The instructional model involves individualized instruction and integration of technology which is great for me. My teaching world is becoming far more computer oriented and I am beginning to see ways I can enable students by using the computer for certain aspects of their learning. Especially if I keep my notes in an organized fashion, along with worksheets and exercises, I can give the work to students who are absent from class.

Journal Entry #7

Question 1. Class Progression

I was quite pleased with the way stack six was created. I enjoyed reading the study and then doing some exercises immediately following. The amount of information was not at the overkill level. What I mean is that I like to receive a little theory, then I like to interact with the computer and do some exercises. If too much information is given to me before I get a chance to use it in practice, I become disinterested. Today was just great.

Question 2. Impact of Computer-based Courseware

I am sure that I have a better understanding of the concepts dealt with in this course as a result of the computer. The textbook and lecture would have helped me in the short-term but not the long-term.

Question 3. Structure of Course

Once again learning at my own individual level is good but I enjoy the interaction with my peers and this approach addresses my learning style needs.

Journal Entry #8

Question 1. Class Progression

Today, I worked on answering questions dealing with quantitative research and I thoroughly enjoyed it. It was a change of pace. I am also trying to reflect on my experience over the past month. I am amazed at the amount of information I have processed. It is incredible. In fact, if you told me a year ago that I would be using different programs on computers, as well as buying my own computer, I would have laughed in your face. Now I quite enjoy what I'm learning.

Question 2. Impact of Computer-based Courseware

I am impressed with what and how we have learned the course material. However, I am well aware that there are some glitches to be ironed out (interaction exercises), Overall, the course was great.

Question 3. Structure of Course

If I can relate and organize my classes with the same approach towards individualizing instruction as this course has been, I will be very happy.

The journal entries indicate that students felt they learned more about research and statistics using the HyperCard-based courseware combined with a guided discovery/expository teaching approach. Student reflections also indicate that they might consider incorporating a technique similar to the research stacks, in their own classrooms.

Quantitative Results

The attitude surveys were analyzed to evaluate changes in students' perceptions and feelings about research and statistics, and computers, both before and after the course. The surveys addressed feelings of anxiety, confidence, liking, and usefulness of research and statistics, and computers.

While 85 students actually used the HyperCard-based courseware, the results presented here reflect 46 participants who agreed to complete the surveys and journals. Table 1 presents demographic information about the 46 research participants.

Each student was asked to classify their level of computer use. Figure 2 represents the subjects level of computer use. It is interesting to note that none of the participants considered themselves expert computer users. When analyzing the attitude scales by level of computer use, there is a significant difference between lower level users (N=22) and higher level users (N=23) on the computer attitude survey only ($F_{pretest}=52.64$, $F_{posttest}=45.99$ $p<.05$).

The attitude surveys were comprised of statements addressing anxiety, confidence, liking, and usefulness of computers and research and statistics. Table 2 presents the subscale means and standard deviations for the pretest and posttest surveys. An ANOVA was conducted to determine whether changes due to the intervention (the use of computer courseware) were significant from pretest to posttest. No significant differences were found from pretest to posttest for the computer attitudes, however, attitude toward research and statistics did improve significantly.

Additional analysis indicated that there were no significant differences from pretest to posttest surveys as a result of the instructor, user level, gender, age, or years of teaching experience.

There was little relationship between responses on the research and statistics attitude survey and the computer attitude survey with a pretest correlation of .39 and a posttest correlation of .074 on the total scales.

Conclusions

The results indicate that students felt better about research and statistics when the HyperCard-based courseware was used in conjunction with an expository/guided discovery instructional approach. While there was no statistically significant improvement in attitudes toward computers, journal entries indicated that students enjoyed using the computer as an integral part of the course, and felt they might integrate individualized instruction in their own classes by creating or using computer courseware. The students also commented that the computer courseware helped to individualize the instruction in the research and statistics course.

In general, the use of the HyperCard-based courseware helped the students to overcome their anxieties about research and statistics. Through the journal entries students indicated helpful sections of the computer courseware. They also helped to identify areas that needed revision.

Upon completion of several revisions to the computer courseware, a presentation will be made to additional faculty members who will be involved in the teaching of

Table 1
Demographics of Research Participants

Gender	Male	32	(71%)
	Female	13	(28%)
	Missing	1	(1%)
Primary Computer Platform	Macintosh	24	(53.3%)
	IBM/DOS	18	(40%)
	Other	3	(6.7%)
Age	Range	0-53 years	
	Mean	42.3 years	
Years Teaching	Range	0-32 years	
	Mean	16.7 years	

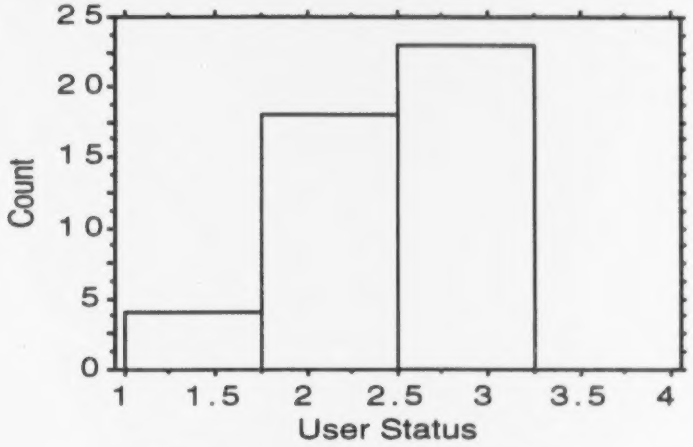

Figure 2. Level of Computer Use.
(1=Novice, 2=Advanced Beginner, 3=Experienced, 4=Expert)

research and statistics in the future, with the goal of fully integrating computer technology into instruction in the research and statistics course.

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Table 2
Subscale means for pretest and posttest surveys (N=46)

	Pretest		Posttest			
	Mean	SD	Mean	SD	F	p
Computer Anxiety	41.30	5.86	42.35	5.39	.788	.37
Computer Confidence	40.50	6.97	41.95	6.93	1.009	.31
Computer Liking	39.87	7.03	40.97	7.20	.558	.46
Computer Usefulness	40.84	5.83	41.65	5.23	.485	.49
Total Computer Attitudes	162.52	24.4	167.19	23.60	.870	.35
Research & Statistics Anxiety	30.72	6.65	33.59	6.23	4.559	.03*
Research & Statistics Confidence	28.87	7.80	32.17	7.49	4.289	.04*
Research & Statistics Liking	28.78	8.16	32.02	7.54	3.910	.05*
Research & Statistics Usefulness	29.80	6.53	32.13	6.58	2.894	.09**
Total Research & Statistics Attitudes	118.17	27.28	129.69	26.69	4.192	.04*

* p<.05
** p<.1

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Technology Intensive Calculus for Advanced Placement: Evaluation of a Summer Workshop

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The Technology Intensive Calculus for Advanced Placement (TICAP) project is a cooperative effort between Clemson University, The College Board, and Educational Testing Service. The project is funded by the National Science Foundation, with substantial support from the Hewlett Packard Company and Texas Instruments, Inc.

In 1992, at the end of the grading of the AP Calculus examinations, 236 high school, college, and university faculty members attended a three-day Institute that prepared them to lead workshops which would help AP Calculus teachers learn to use graphing calculators effectively in instruction. Of the participants, there were 200 invited participants, 14 South Carolina guests, the members of the TICAP Team, and almost all of the living past committee chairs and chief faculty consultants in the AP Calculus program. The group now constitutes a cadre of educators prepared to be teachers of teachers. Comparable Institutes, planned for 1993 and 1994, will facilitate The College Board's planned implementation of the required use of graphing calculators on AP Calculus examinations beginning as early as 1995.

TICAP participants are able to lead workshops for AP Calculus teachers across the country in which improved methods of teaching mathematics are demonstrated. These workshop leaders, then, represent a forceful mechanism for change in both high schools and colleges. TICAP represents the best of systemic change; that is, working *with* national programs to cause significant and comprehensive change of the kind desired and endorsed by the leaders in a content discipline. Indeed, much of secondary mathematics is preparation for calculus, and more and more college majors are required to meet and overcome the traditional science and engineering calculus barrier. The mathematics community has called for calculus to be a "pump and not a filter," and many of the resulting open access proposals merge technology into the traditional curriculum. If the AP program is to do this, then AP Calculus teachers must have specialized instructional materials. The TICAP project addresses those needs.

In addition to the assurances that the project gives to The College Board that AP Calculus teachers will be prepared to deliver technology-enriched instruction, TICAP will indirectly impact mathematics instruction in two other significant ways. First, schools will be motivated to improve precalculus programs to prepare for changes in the AP program. Second, as AP Calculus students, with technology-enhanced secondary instruction, enter post secondary education they will naturally expect and be prepared to handle mathematics instruction that takes advantage of today's computers and calculators. Colleges and universities will have to respond to the expectations of those students.

The TICAP project has four goals:

1. To increase and improve the conceptual and problem-solving content of existing calculus courses by developing instructional materials that take advantage of graphing calculator technologies.
2. To increase teacher competence through participation in

workshops delivered by colleagues especially trained in effective use of graphing calculators in calculus and precalculus instruction.

3. To create incentives for incorporation of computing technologies into calculus courses.
4. To explore ways that graphing calculators can help currently under-represented groups to improve their access to and successful completion of calculus courses.

The Institute was structured around a series of plenary sessions on calculus content and equity issues. After each plenary session dealing with content, there were discussion groups, in which the content of the session was amplified and uses of graphing calculators (from both Hewlett Packard and Texas Instruments) were demonstrated and discussed. Discussions and demonstrations were centered around problems prepared by the TICAP team prior to the Institute.

Evaluation Instrument and Analysis Plan

Items in the evaluation instrument were developed to match major components of the Institute. Demographic variables (e.g., teaching level) were selected to measure expected major differences among participants.

Responses were available from 108 participants, though virtually all forms had at least one missing datum. Quantitative data were analyzed using analysis of variance (ANOVA) for each of four demographic variables: (a) teaching level (high school, university); (b) number of years teaching calculus (0-4, 5-14, 15 up); (c) number of courses taught with graphing calculators (0, 1-2, 3-5, 6-10); and (d) experience as a workshop leader (1, 2, 3, 4, 5). Responses to open-ended questions were entered into a concordance program. Categories of responses were created by examining the concordance printout; responses were then tallied according to these categories. For each open-ended item, many of the forms were blank. This suggests that most participants were basically satisfied and held no strong positive or negative feelings about the 1992 TICAP Institute.

Results and Discussion

This report focuses on the plenary sessions; data on becoming better prepared to deliver workshops have been reported earlier (Bright & Williams, 1993). Plenary sessions are listed below with associated question numbers. Participants rated each session on three scales: overall quality, quality of presentation, and usefulness in explaining integration of graphing calculators into calculus. Descriptive data are presented in Table 1.

7. The Power of Visualization in Calculus
8. Making Calculus a Pump, Not a Filter
9. Functions and Limits
10. Graphs and Continuity
11. The Derivative
12. Applications of the Derivative
13. Integration
14. Sequences and Series
15. Women in Mathematics

Table 1
Overall Means

	a: Overall Quality		b: Quality of Presentation		c: Usefulness for integrating calculators	
Question	*n*	Mean	*n*	Mean	*n*	Mean
7	96	4.21	96	4.28	95	4.12
8	97	3.33	95	3.33	94	2.90
9	95	3.80	95	3.89	91	3.82
10	95	4.35	93	4.29	92	4.30
11	97	4.37	96	4.46	95	4.39
12	96	4.28	94	4.34	95	3.82
13	95	3.96	92	3.97	90	3.82
14	91	3.71	92	3.79	90	3.28
15	70	3.23	69	3.12	63	2.13

Generally the ratings are high, suggesting that the lectures addressed the needs of participants. Based on rankings of overall quality, however, the lectures seem to fall into three distinguishable subsets. The highest-rated plenary sessions (question number) were The Power of Visualization in Calculus (7), Graphs and Continuity (10), The Derivative (11), and Applications of the Derivative (12). The next highest-rated plenary sessions were Functions and Limits (9), Integration (13), and Sequences and Series (14). The lowest-rated plenary sessions were the panel discussion Calculus as a Pump, Not a Filter (8) and the lecture Women in Mathematics (15).

There were essentially no differences in rankings of overall quality and quality of presentations, but a few of the lectures were rated somewhat lower on usefulness in explaining integration of graphing calculators into calculus: in the highest-rated sessions, lecture 12 only; in the next highest-rated sessions, lecture 14 only; in the lowest-rated sessions, both sessions 8 and 15. The topics of the highest-rated plenary sessions dealt with fundamental content of calculus and with fundamental uses of calculators in teaching calculus. The topics of the lowest-rated plenary sessions dealt with issues of equity that may not have been viewed by participants as directly related to the use of calculators in teaching calculus.

In order to refine understanding of the ratings, data were subjected to ANOVA. Follow-up tests were computed for all significant or marginally significant ($p < .10$) *F*-values (Table 2).

The only differences that were significant at the .05-level were between high school and university teachers. None of the other demographic variables produced significant differences, though there were some marginally significant comparisons (i.e., $.05 < p \le .10$).

Three of the four significant comparisons were differences in perceptions of usefulness for explaining the integration of graphing calculators into calculus (questions

Table 2
Follow-up Data for Significant ANOVAs

Teaching Level

		High School			University		
Question	*p*	*n*	Mean	*sd*	*n*	Mean	*sd*
8a	0687	66	3.18	1.2	31	3.65	1.1
9a	.071565	3.69	0.9	30	4.03	0.7	
9b	.096765	3.78	1.0	30	4.13	0.7	
9c	.030362	3.68	1.0	29	4.14	0.7	
10a	.047863	4.46	0.8	32	4.13	0.8	
10c	.035061	4.42	0.8	31	4.06	0.8	
13b	.057361	3.84	1.0	31	4.23	0.8	
15c	.014740	1.80	1.2	23	2.70	1.7	

Number of Years Teaching Calculus

		0-4			5-14			15 up		
?#	*p*	*n*	X	*sd*	*n*	X	*sd*	*n*	X	*sd*
10a	.07426	5.00	0.0	36	4.42	0.7	57	4.26	0.9	
12a	.08846	4.17	1.6	36	4.06	1.0	59	4.46	0.7	
12b	.07206	4.17	1.6	35	4.11	1.0	58	4.52	0.6	
14b	.09494	4.75	0.5	38	3.63	1.1	55	3.89	1.0	

Number of Courses Taught with Graphing Calculators

		0			1-2			3-5			6-10		
?#	*p*	*n*	X	*sd*	*n*	X	*sd*	*n*	X	*sd*	*n*	X	*sd*

9c, 19c, 15c); two of these three (questions 9c, 15c) represent perceptions of greater usefulness among university teachers as compared to high school teachers. If one subsumes issues of integrating calculators into instruction within the broad domain of pedagogy, this result is consistent with the speculation that university teachers are generally less knowledgeable about issues of pedagogy than high school teachers. It is not clear why limits and gender equity were the areas in which university teachers found pedagogy concerns more relevant.

The two significant differences favoring high school teachers dealt with the lecture on graphs and continuity: overall quality (question 10a) and usefulness in explaining integration of graphing calculators into calculus (question 10c). The content of this lecture seems to have been more important or critical for the high school teachers. This result might reflect a higher level of knowledge about continuity among university teachers or it might reflect the need that high school teachers have for finding explanations of this difficult concept that make sense to high school students.

Conclusions

The data suggest that if technology workshop interventions deal with issues globally, then subgroups of participants may not be served equally. The Concerns Based Adoption Model (Hall & Hord, 1987) is one conceptual framework within which needs of subgroups of participants can be interpreted, but experience with content and types of students taught might be equally important issues for understanding the impact of the workshop on subgroups of participants. Workshop leaders, of course, expect that participants will come with different needs (e.g., how to use a graphing calculator, how to organize a workshop for teachers), and those needs can often be anticipated in the workshop planning. However, it is more difficult to imagine how participants will interpret and internalize what occurs during the workshop through the filter of their teaching experience (e.g., length of time teaching the content, level of students taught). Much more investigation of the effects of this filter is needed.

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Computer Programming: A Medium for Instruction and Learning

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The first microcomputers, introduced to the schools in the late 1970s, were used almost exclusively to teach students to program. Since then, the teaching of programming has remained a part of computer education but its position of primacy has eroded. Programming now accounts for only a small part of computer use in most schools.

The past fifteen years have witnessed tremendous advances in the computer hardware available for school use and in the quantity and quality of educational software, accompanied by an evolution in thinking about how computer technology can best be used in the service of the educational process. Presently, computers are used in schools primarily as tools, such as word processors, spreadsheets, and databases and as platforms for drill and practice and other computer-assisted instruction (CAI). Some argue that in the future the need for computer-based tools will determine whether schools buy computers at all, and other uses in schools will persist only to the degree that this need for tools is met (Collins, 1991). Certainly computer-based tools have already and will continue to influence how work is done both in and out of school, and while these uses should be encouraged, there is a wide range of other computer applications that have the potential to enrich the teaching and learning process at all levels. In particular, computer programming — once the *only* computer application used in schools – should remain as one in the suite of such activities because of its inherent problem-solving nature.

This paper will examine the change in emphasis, from programming as the sole computer application to its position as but one piece of the curriculum, and usually a minor one at that, and will argue that programming is an activity that fits naturally with the current emphasis on teaching problem-solving and higher-order thinking skills. It will suggest necessary preparation for teachers who are to use programming in their teaching, and finally, it will outline a model course in programming for teachers pursuing advanced training in computer and technology education.

What is Programming

Computer programming involves writing a set of instructions directing a computer to carry out a specific task. A computer programmer, therefore, analyzes a problem, designs a solution, and then teaches a computer how to do a specific task by writing a program. There are many languages that have been devised for programming computers — from BASIC, which was built into early microcomputers and thus began the programming movement in schools, to the new, highly popular hypermedia languages. Essential to the discussion in this paper is the fact that the basic concepts and constructs of programming are the same across all computer languages. Programming requires constructs for input of data, output of data, internal processing of data, making choices, and controlled repetition. At a more advanced level, file and data structures must be available. An expert programmer codes in a particular programming language with mastery of the syntax of that language, but also understands the generalized nature of programming concepts she is using. For the purpose outlined in this paper, that more general understanding of programming is emphasized. I argue that this general understanding can be efficiently mastered without necessarily developing expertise in any particular vocabulary or syntax, through a focus on the generalized constructs that underlie all programming.

Traditionally school-taught programming focuses on the most basic level of skill development in a specific language, not unlike the traditional focus in other subjects. Rather than approaching the study of programming — or science, mathematics, or history, for that matter — from the perspective of the underlying conceptual structure from which facts and details emerge, it is, all too often, the details that are emphasized in the instructional process. These facts and details, without their underlying conceptual structure, burden the student with unrelated information, and while a student may *know* the syntax of a language (or the basic math facts or facts about the periodic table, for example), he is unable to apply that knowledge in attempts to solve problems that arise outside specific subject instruction. Computer programming, if it is to be more than the most mechanical treatment of the simplest tasks, requires more than just a knowledge of vocabulary and syntax. Like traditional school subjects, it has a conceptual framework which makes the study of programming a complete and holistic activity. Professional programmers see their work as more than just stringing together instructions to make a computer work.

Michael Hawley, a programmer for Lucasfilms, Inc., views programming as a complex cognitive skill: *What I like about programming is that it really helps you think about how we communicate, how we think, how logic works, how creative arts work* (Lammers, 1986, p. 311). In the same vein, Ray Ozzie, who produces software for Lotus, considers programming to be an ideal medium for creativity: *Programming is the ultimate field for someone who likes to tinker* (Lammers, 1986, p. 186). Bob Frankston, the programmer of VisiCalc, points to the metacognitive nature of programming when he says: *If you cannot explain a program to yourself, the chance of the computer getting it right is pretty small* (Lammers, 1986, p. 159).

Why Teach Programming

Programming has been a part of the computer curriculum since the introduction of microcomputers into the schools in the late 1970s. However, in the last 15 years computer technology has evolved so much that the first school computers are now viewed as very primitive devices, and early computing activities in schools are considered as unsophisticated attempts to marry technology to instruction. This revolution in computer hardware has been accompanied by an evolution in thinking about how computer technology should be used in education. The change in thinking about programming's place in the curriculum mirrors this evolution in the application of technology to the educational enterprise and the focus on concept development resulting from modern learning theory.

While most early microcomputers came equipped with the programming language, BASIC, very little other software was available, and so educators who wanted to use computers were essentially confined to teaching BASIC. In fact, there was little *teaching of programming* going on. What was being taught was *BASIC*, vocabulary and syntax. Teachers were encouraged to learn BASIC so that they could write their own educational software; administrators, arguing for computer funding for their schools, claimed that it was necessary to teach programming to all students to better prepare them for a technology-rich future. Everything pointed to a computer-dominated future which would demand a work force of computer programmers.

However, by 1984 many educators were taking issue with the emphasis on teaching BASIC (and by then some other languages as well) as a route to a future job market. In 1985, Joseph Weizenbaum, one of the most thoughtful critics of computers in the schools stated: *but I oppose the idea of teaching programming as a form of computer literacy - something children are supposed to need for a future world pervaded by computers. Oh, there's no doubt that our world will be pervaded by computers. But they will be essentially invisible in the same way that electric motors are invisible; we use electric motors all the time, but we don't have to be trained as electrical engineers to do so* (Brady, 1985, p. 25).

By that time, it was obvious that technology was changing so rapidly that technology-specific tasks learned in elementary and high school would be outdated when those students entered the work force. No one could predict what the hardware would look like in ten or fifteen years and certainly languages were so rapidly evolving that emphasis on any one language could no longer be justified under the "preparation for the work-force" argument. The thrust of educational computing overcorrected in response to criticism, essentially throwing out most teaching of programming for a short while. However, the inherent value of programming continued to be recognized, and during the past ten years or so, we have witnessed waves of favor and disfavor.

The introduction of Logo in the early 1980s and the continued use of Logo served to keep the teaching of programming alive in the schools even in times when traditional programming fell into disfavor. Logo was introduced solely as a medium for achieving curricular goals other than skills in programming. Seymour Papert, Logo's creator, intended to provide young students with a means of creating microworlds for the exploration of mathematical concepts, and saw the debugging required during programming as an excellent way for students to develop problem-solving skills. In schools where Logo is introduced to children in the manner intended by Papert, it serves as a medium for the development of conceptual knowledge and as a means to learn and practice thinking skills. Although the use of traditional programming languages had, for the most part, fallen into disfavor, reports of positive findings from schools using Logo kept alive the idea that programming had a place in the curriculum.

Historically there have been several rationales for including programming instruction in the curriculum. It is argued that in learning to program, students develop an understanding of how a computer operates. There are two aspects to this position. First, programming students *use* computers, and anyone who uses a computer *will* develop a better understanding of the machine and gain confidence in using the tool. Second, programming students learn a language to communicate with a computer and thus gain an understanding of logic of computer operation. However, with the arrival of large numbers of other computer programs, this is no longer a compelling reason to teach programming. Students routinely use computers for a wide variety of activities (both in and out of school), furthermore, the logic of computer use has become more and more removed from the average user because of the introduction of higher level user interfaces.

Others claim that programming involves the use of higher-order thinking skills and therefore, instruction in computer programming and subsequent programming experience has a direct, positive effect on the development of these skills. There is no question that successful programmers use higher-order thinking skills to write effective, well-designed programs. The mostly unanswered question is whether already clear and logical thinkers become successful programmers or whether people can become clear and logical thinkers by writing computer programs (Vockell and van Deusen, 1989). A number of researchers has attempted to answer this question. Pea and Kurland (1984), for example, failed to observe the predicted benefits of greater planning and other higher-order thinking skills in students learning Logo programming.

Closely related to the thinking skills claim is the assertion that programming can be a fertile ground for the development and practice of problem-solving strategies. Programming is an activity made up of many components such as comprehension of a problem, composition, debugging, and verification. For many years now, it has been argued that successful programming demands an interaction of many complex cognitive skills (Irons, 1982; Shneiderman, 1980). Many of these skills appear to be similar to the skills identified as those required for effective problem solving. Thus, computer programming should provide a fertile field for instruction in problem solving.

One of the most demanding components of programming is debugging, the process of locating and correcting errors in a faulty program (Myers, 1978; Vessey, 1985). Debugging is a continuous cycle of generating hypotheses and testing solutions until the error is found. As such, debugging has the hallmarks of an excellent problem-solving activity. The teaching and subsequent practice of debugging involves students in the practice of problem-solving activities in an environment that is at once both engaging and challenging (Casey, 1991).

There is ample evidence that the problem-solving skills of our pre-college students need to be strengthened, yet the generally acknowledged failure of existing approaches to develop and improve these skills, including that of overtly stressing work on problem solving as part of the mathematics curriculum, does not seem to have worked. Clearly, more effective alternatives are needed. Because computer programming has the potential to provide students with a forum for problem solving that is both challenging and engaging, it is an alternative curriculum area for teaching and practicing problem solving. Students involved in a well-taught programming course are given the freedom to analyze problems, to design solutions, and to strive at making those solutions *work*, thus giving them a sense of ownership of the problem.

Because of the nature of the task, mistakes, or programming bugs, are almost certain to be a part of any newly written program. In the writing of programs, students actually create their own bugs, thus the task of problem solving becomes even more personal. Programming, then, allows the student problem solver to become not only a problem solver but also a *problem poser*. This aspect of problem solving is often neglected in traditional instruction. Giving students the freedom to design and write their own programs, presents them with the opportunity to pose problems, to solve these problems by writing computer programs, and to practice problem-solving skills while debugging their own problems. It is this intense practice at problem solving that provides for the most important characteristic of a good problem solver: a fund of experience.

The Need for Teacher Training

In the early days of educational computing, programming was taught by teachers who, for the most part, were self-taught programmers. Many of these programming teachers were computer enthusiasts, but they had neither deep domain-specific knowledge nor an understanding of the pedagogical requirements of teaching programming. If all one needs to teach a subject is knowledge of the subject, then every experienced computer programmer would be a good programming teacher. This belief denies the existence of a body of knowledge of teaching, and the importance of an understanding of teaching and learning. I argue that a good teacher of programming must possess two sets of skills: a knowledge of programming and a knowledge of *how to teach* programming.

Perhaps this is where the early experience with programming went so wrong. Programming was taught for the sake of learning a specific language. Programming was a new curricular area, and theory and practice of teaching programming had not yet developed into a pedagogy. As Marshall McLuhan would say the medium *was* the message. A more enlightened view sees programming as a medium for teaching and practicing other concepts and skills. The teacher needs specific training to understand that programming is such a medium, and to avoid confusing the knowledge of "programming" in a specific language (and as an end in itself), with the other educational goals that are achievable using programming. The notion that teachers, if they are to introduce programming concepts, have a responsibility to become familiar with how computer programs should be developed is not the same as requiring teachers to become *professional* computer programmers. To fully master a programming language and be able to work professionally as a programmer requires much time and effort. Rather, what is intended is that teachers gain a conceptual understanding of programming techniques as well as hands-on experience with computers, using one or two programming languages that are popular in the schools (Brownell, 1992). These teachers then need to develop expertise in problem solving and the pedagogy of teaching programming so that the programming skills that they have developed can be put into a curricular context. Most studies of student programmers that fail to show transfer of skills learned in programming to other curricular areas cite, as a possible reason for this lack of transfer, failure of teachers to facilitate that transfer. Learning to solve problems or to exercise other higher-order thinking skills is not intrinsically guaranteed by working in a computer programming environment; it must be supported by teachers who know how to foster the development of such skills through judicious use of examples, projects and direct instruction (Pea & Kurland, 1984).

What to Teach Those Who Teach Programming

Students completing degree programs in educational computing and technology will be expected to teach, or support those who teach, programming in the schools. If elementary and high schools are to be encouraged to use Logo, Pascal, and HyperTalk as media for teaching and practicing thinking and problem-solving skills, teachers must be prepared to facilitate such environments. Since the concepts and constructs underlying the logic of computer programming are the same for all languages, preparation in teacher education programs should focus on those generalized concepts and structures, as illustrated in a variety of languages, rather than the mastery of any one language. Because of the emphasis on the development of thinking skills, the focus is not on the training of programmers but on providing a forum for the learning and practice of thinking skills. Students completing a master's degree in educational computing and technology should be equipped to support the teaching of programming from this perspective.

A Model Course

At the University of Hartford, we have a master's program in computing and educational technology. Graduates of this program find employment as elementary and high school teachers, as special education teachers, as school and district-wide technology coordinators, and in adult training environments using technology to support learning. Most of these educators require a knowledge of programming either for their own teaching or to support those who use programming in instruction. Instruction in any one specific language would not satisfy the needs of such a diverse group.

Additionally, we have found that other courses in our program are more successful if students have a good grounding in the concepts developed during programming practice. Courses in design and evaluation of educational software, multimedia production, and robotics require the framework provided by a knowledge of programming. Again it is not knowledge of one programming language that is required, rather, it is the knowledge of what underlies all programming languages. The course that we use to provide this background for our students is called *Educational Technology: Programming Concepts*.

This course provides in-depth exploration of the concepts and constructs underlying all educational software. The students use a variety of computer programs, to examine how computer programs are built and discuss how computer programs can support a variety of learning styles. Students are expected to analyze commercial educational software and to design and code a simple educational application in the language of their choice. The objectives for this course include:

- Analysis of the underlying structure of a computer program
- Suggestions of realistic and implementable improvements for a piece of educational software
- Creation of a storyboard/flowchart for an educational application, indicating the essential programming structures
- Definition of and explanation of the underlying constructs and concepts in computer programs
- Implementation of at least a skeletal version of an educational application in a programming language of the student's choice (Logo, Pascal, HyperTalk, QuickBASIC)
- Discussion of how and why certain educational applications are appropriate for students with different learning styles

Students enrolled in this course attend class for three hours per week. Class sessions consist of lectures, demonstrations, and discussion of sample applications. Students are required to spend an appropriate amount of time in the computer lab completing the following requirements. Students are expected to:

1. Write an analysis of a selected educational application, discussing how the program was created and suggesting modifications. The student will be expected to incorporate suggestions for improvement or extension based on his/her knowledge of learning theory and programming practice.
2. Write a script of a computer program incorporating language appropriate for a target age group and justification for the program based on knowledge of development needs of the target group. The script will be expanded into a storyboard and/or traditional flowchart for a computer program.
3. Code a computer application using one of the languages commonly used in pre-college settings (Logo, Pascal, HyperTalk).

A sample syllabus for *Educational Technology: Programming Concepts* is shown in Table 1 to illustrate the range of topics covered during classroom sessions. This

Table 1

Sample Syllabus for *Educational Technology: Programming Concepts*

Session	*Topic*
1.	Introduction and overview: Demonstration of commercial and student created software and a discussion of the utility of such programs.
2.	Programming concepts introduced: Internal processing, input, output, whiles (repetition), eithers (choice).
3.	Demonstration programs followed by whole group and small group analysis based on programming constructs introduced above.
4.	Flowcharting and storyboarding.
5.	Advanced constructs: File and Data structures explained. Logo lesson and demonstration of data structure.
6.	Learning theory and computing.
7.	Analysis of computer programs (Simulation, Problem solving, and CAI) and a discussion of the constructs present in each. These programs will be coded in a variety of languages.
8.	Group design, storyboarding and coding of a simple application ("Create your own fiction" using Logo).
9.	Review of constructs. Comparative examples using Logo, Pascal, and HyperTalk.
10.	Why teach programming? What language should be used?
11.	Problem solving. Algorithms and heuristics. A problem-solving model.
12.	The debugging process. A group debugging activity.
13.	Critiques. Student demonstrate their applications others give written critique.
14.	Final exam. Students reply to written critiques. Students analyze a new educational application.

syllabus is adjusted from semester to semester to accommodate the needs and experience of the course participants.

Conclusion

The debate about the teaching of programming in schools has not attenuated in the past decade. The arguments, however, still mostly center on the teaching of programming as preparation for jobs. However, if computer programming provides a rich, challenging environment for the learning and practice of problem-solving skills and other thinking skills, it can be argued that it should be a part of any school curriculum whose goals include the teaching of such skills. It is a positive way to address one of the most vital problems facing our schools: our children are not, at present, developing problem solving and other thinking skills. The teaching of programming can be one positive solution.

Of course, it is crucial that in the inclusion of programming in the school curriculum, we focus on *excellent* teaching. Teachers of programming need specific domain knowledge (in this case, computer programming) but they also need to fully understand problem solving and the heuristics involved. Further they must be aware of the pedagogy needed to assist students in making the transfer of skills learned in programming to other areas of the curriculum and, indeed, to other situations outside school.

The course described in this paper was designed to prepare teachers to teach programming from this perspective. The intention of the course is to provide teachers with a broad understanding of programming as a process and its focus is to prepare teachers to teach programming, not as a skill in itself, but rather as a medium for the development and practice of problem-solving and thinking skills.

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Will Different Types of Computers Affect Inservice Teachers' Learning of Computers?

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Recently, there has been an emphasis on examining how students' perform in different computer learning environments. The discussion has raised the comparison between Macintosh computers (MAC) and IBM PC's (IBM) (Halio, 1990; Heid, 1991; Kaplan & Moulthrop, 1990; Levy, 1990; Slatin, 1990; Youra, 1990). One article, particularly, compared these two types of computers from a technical viewpoint including such factors as expansion flexibility, running speed, and ease of use and concluded that "the Mac is the better computer, but the (IBM) PC remains the better computing value" (Heid, 1991). Another study conducted by Williams compared the Macintosh and IBM PC in laboratory applications and concluded that "the IBM PC is the most useful general-purpose personal computer for laboratory applications" (Williams, 1986, pp. 129). Halio (1990) also conducted a study to compare students' writing in MAC or IBM computer learning environment, and reported that students using IBM computers wrote better than those using MAC computers. Although, several articles argued that Halio's study was flawed by poor experimental design and was filled with questionable logic and evidence (Kaplan & Moulthrop, 1990; Levy, 1990; Slatin, 1990; Youra, 1990), the results of these studies seem to favor the IBM PC in terms of its technical features and usefulness. Since MAC and IBM are two types of computers that have been widely used in the educational setting, it is important to examine students' performance and attitudes toward computing in a MAC or IBM computer learning environment.

Research objectives

The major purpose of the present study was to examine the effects of different types of computers on students' performance and attitudes toward computers. More specifically, the study attempted to examine the effects of: (a) types of computers (i.e., Mac vs. IBM); (b) gender (i.e., male vs. female); and (c) measurement occasion (pretest vs. posttest) on inservice teachers' knowledge of computer literacy, misconception about computing concepts, and attitudes toward computers.

Fundamental computing concepts

Galloway (1987, 1990) has developed a theoretical model to demonstrate the relationships among five computing concepts. In his model he defined a *command* as an instruction to the computer that calls for an immediate action. Computer *data* is information typed into the computer by the user; it is also information reported to the user that is generated by the computer itself. A *file* is a named location on a disk that contains some type of information, either a computer program or stored data. A computer *program* is a list of instructions (commands) designed to perform a task or tasks. And the term "computer *language*" refers to the set of rules which allow the computer to interpret commands calling for some specific action and establishing the allowed syntax for commands. The five computer concepts selected for the present study followed the theoretical model developed by Galloway (Galloway, 1987, 1990).

Attitudes toward computers

Computer attitudes refer to "an individual's feeling about the personal and societal use of computers in appropriate ways. Positive attitudes include an anxiety free willingness or desire to use the computer, confidence in one's ability to use the computer, and a sense of computer responsibility" (Simonson, Maurer, Montag-Torardi, & Whitaker, 1987). Loyd and Gressard (1984) categorized computer attitudes as computer anxiety, computer confidence, and computer liking.

Method

The following section describes the subjects, instruments, and the computer literacy course used in this research study.

Subjects

The subjects participating in the present study were 38 inservice teachers in a state-supported, public university located in a major metropolitan city in the Southwest. Nearly 68% of the subjects were female and about 89% of them were white. In addition, 62% of the subjects were between the ages of 18 and 35. The teacher education program in the university participating in the present study requires all students majoring in education to complete an introductory computer literacy course. Owing to the limited number of computers in the College of Education, the course was taught in two different computer labs. One lab was equipped with 18 networked Macintosh Plus (MAC) computers, and the other lab had 15 networked IBM PS2 (IBM) computers. Students enrolled in the course were free to choose from the two labs, however, each lab would only accept the first 20 students enrolled. As a result, 18 inservice teachers enrolled in the MAC lab, while 20 inservice teachers enrolled in the IBM lab.

Computer literacy course

The content of the computer literacy course taught by the university involved in the present study included: (a) word processing; (b) database; (c) spreadsheet; (d) Logo; and (e) BASIC. This model of computer literacy was consistent with that proposed by Thompson and Friske (1988) in which several applications were emphasized and programming was only a component part. The general expectation for the course is for education students to achieve a simple level of operation of applications software (e.g., word processing) and to write simple programs in Logo and BASIC.

Microsoft Works 2.0 was selected as the major software for students in both classes to learn word processing, database, and spreadsheet applications. Additionally, Object Logo 2.0 and Microsoft BASIC 2.0 were used in the MAC lab, while Logowriter 2.0 and GW BASIC were used in the IBM lab. Two experienced instructors, one with a doctoral degree and the other with a masters degree in instructional technology, were chosen to teach one of the two classes. Both instructors have extensive experience teaching computer literacy courses at a variety of grade levels.

Instruments

Three instruments were used in the present study. First, to evaluate inservice teachers' computer literacy, the Computer Literacy Examination: Cognitive Aspect (CLECA) developed by Cheng, Plake, and Stevens (1985) was selected. The CLECA was developed to assess students' general knowledge about computers. The internal consistency alpha value and the test-retest reliability for this 32 item test were .87 and .90 respectively.

Second, to assess inservice teachers understanding about essential computing concepts, a computer concept test was developed by Galloway (1987, 1990) that was designed to measure preservice teachers' misconception about the computing concepts of: (a) command; (b) data; (c) file; (d) language; and (e) program. The test consists of 40 multiple choice questions, eight on each of the five concepts. The test has been found reliable and valid, and has been previously used with preservice teachers (Galloway, 1987, 1990).

Third, to investigate inservice teachers' attitudes toward computers, the Computer Attitude Scale (Loyd & Gressard, 1984), which consists of 30 Likert-scale divided into three ten-item subscales: computer anxiety, computer confidence, and computer liking, was adapted. Alpha reliability coefficients of the computer anxiety, computer confidence, and computer liking were .87, .91, .91, respectively. The results of the factor analysis for this instrument also showed high intercorrelation among the subscales (Loyd & Gressard, 1984). In addition, the instrument has been previously used with students at varied school levels (Loyd & Gressard, 1984; Loyd & Gressard, 1986; Loyd & Loyd, 1988; Massoud, 1990; Massoud, 1991).

Procedures

Because the random assignment of subjects was not possible, the nonequivalent control-group design was selected for the present study (Borg & Gall, 1983). At the beginning of the Spring academic semester, 1991, all 38 subjects completed all three instruments. The subjects, 18 in the MAC lab and 20 in the IBM lab, then completed the 16-week Computer Literacy course. The same instruments were administered to all subjects near the end of the academic semester. Owing to some personal problems, four subjects in the IBM group did not take the posttest, their data was therefore deleted from the posttest analysis. The pretest and posttest data were collected and coded.

Data analyses

Nine one-way analysis of variance tests (ANOVA) were employed for all dependent variables (achievement, command, data, file, program, language, computer anxiety, computer confidence, and computer liking) for the pretest to examine if there were any statistically significant differences ($p < .05$) between two groups (MAC and IBM). To examine if subjects had significant gains from pretest to posttest, nine one-way ANOVAs were performed again for measurement occasions (pretest vs. posttest). Finally, nine 2 x 2 factorial ANOVAs were used for group by gender for the posttest to examine if there were any statistically significant differences: (a) between groups; (b) between gender; and (c) the interaction between group and gender.

Results

Table 1 summarizes means and standard deviations for the pretest. The results of nine one-way ANOVAs for all dependent variables show that there were no significant differences between the Mac group and the IBM group for the pretest, indicating that there were no initial group differences statistically.

Table 2 summarizes the results of nine one-way ANOVAs for measurement occasions. The results show two significant differences. Inservice teachers had significant gains from pretest to posttest at achievement ($F = 6.04$, $df = 1/70$, $p < .05$), and computer anxiety ($F = 5.35$, $df = 1/70$, $p < .05$). No other significant differences were found. The means and standard deviations for the posttest are displayed in Table 3. Overall, inservice teachers had slight to mild increase on their knowledge of computer literacy, misconception about computing and attitudes toward computers after 16 weeks of instruction.

Table 4 summarizes the results of nine 2 x 2 factorial ANOVAs for group by gender in the posttest. The results show one significant difference for gender on the File dependent variable ($F = 8.67$, $df = 1/30$, $p < .01$) and one significant interaction for gender by group on the Data dependent variable ($F = 4.75$, $df = 1/30$, $p < .05$). Male subjects scored significantly higher than female subjects on File. The significant interaction indicates that male subjects in the IBM group had higher scores than female IBM subjects and all subjects in the MAC group on Data. No other significant differences or interactions were found. The means of the posttest for group by gender are displayed in Table 5.

Figure 1 shows the comparison of attitude scores for pretest-posttest differences between the MAC group and the IBM group. Although the group differences did not reach the significant level ($p < .05$), the IBM group had higher pretest-posttest gains than the MAC group for all three subscales. Also, the IBM group developed lower computer anxiety, higher confidence and liking toward computers from pretest to posttest while the MAC group only decreased its computer anxiety. Moreover, the MAC group had higher scores for all three subscales than the IBM group at the pretest, but had lower scores at the posttest.

Discussion

The results of the present study indicate that there were significant differences for achievement and computer anxiety, suggesting that inservice teachers did increase their knowledge of computer literacy and decrease their computer anxiety after 16 weeks of instruction. However, inservice teachers did not significantly improve their understanding about essential computing concepts. Also, they did not significantly increase their computer confidence and liking toward computers. The results of the 2 x 2 factorial ANOVAs indicate that there were no significant differences between MAC and IBM groups on all nine dependent variables, suggesting that, in general, different types of computer learning environments (e.g., MAC vs. IBM)

Table 1
Means and Standard Deviations for the Pretest

	MAC ($N = 18$)		**IBM** ($N = 20$)		**Total** ($N = 38$)	
Dependent Variables	X	SD	X	SD	X	SD
Achievement	18.0[a]	5.4	16.3	6.5	17.1	6.0
Misconception						
Command	6.4[b]	1.4	5.9	1.3	6.1	1.4
Data	4.4	1.4	4.5	1.6	4.4	1.5
File	5.6	1.5	4.9	1.8	5.2	1.6
Program	4.2	1.4	4.8	1.5	4.5	1.4
Language	4.8	1.5	4.9	1.2	4.8	1.3
Total	5.1	1.0	5.0	0.8	5.0	0.9
Attitude						
Anxiety	28.7[c]	6.1	26.3	5.9	27.4	6.1
Confidence	33.2	5.6	31.3	4.9	32.2	5.3
Liking	30.9	6.4	29.8	6.3	30.4	6.3
Total	30.9	4.5	29.1	5.1	30.0	4.9

a. The possible maximum score for achievement is 32.
b. The possible maximum score for each subscale in misconception is 8.
c. The possible maximum score for each subscale in attitude is 40.

Table 2
Summaries of One-way ANOVAs for Measurement

Source	*df*	MS	*F*
Achievement			
Between group	1	203.23	6.04*
Within group	70	33.66	
Total	71		
Misconception			
Command			
Between group	1	4.24	2.21
Within group	70	1.92	
Total	71		
Data			
Between group	1	2.119	.93
Within group	70	2.28	
Total	71		
File			
Between group	1	3.37	1.36
Within group	70	2.48	
Total	71		
Program			
Between group	1	0.26	0.12
Within group	70	2.19	
Total	71		
Language			
Between group	1	5.24	3.08
Within group	70	1.70	
Total	71		
Attitude			
Anxiety			
Between group	1	163.67	5.35*
Within group	70	30.60	
Total	71		
Confidence			
Between group	1	11.94	0.48
Within group	70	24.97	
Total	71		
Liking			
Between group	1	5.56	0.13
Within group	70	43.12	
Total	71		

* $P < .05$

seems to have very little influence on inservice teachers' learning of computers. The only significant difference found for gender on the variable File indicates male inservice teachers may develop better understanding of the concept of File than females after a semester of instruction. The significant interaction for group by gender on Data indicates that male subjects in the IBM seem to understand the concept of Data better than females subjects as well as subjects in the MAC group. This is perhaps the only evidence that can indicate the influence of different computer learning environments on inservice teachers' learning of computers. However, the evidence was too weak to be significant.

The findings that the IBM group had higher pretest-posttest gains than the MAC group for computer attitudes seem to suggest that inservice teachers may develop more positive attitudes toward computers in the IBM computer learning environment after 16 weeks of instruction. Moreover, the results that the MAC group had higher scores for all three subscales than the IBM group at the pretest, but had lower scores at the posttest seem to suggest that the MAC computer is possibly an easier type of computer than the IBM computer for inservice teachers to start with; but as instruction extended to 16 weeks, inservice teachers may change their preference of computers. However, given that the group differences did not reach the significant level, the

Table 3
Means and Standard Deviations for the Posttest

Dependent **Variables**	**MAC** (*N* = 18)		**IBM** (*N* = 16)		**Total** (*N* = 34)	
	X	SD	X	SD	X	SD
Achievement	22.2[a]	4.8	18.5	5.9	20.5	5.6
Misconception						
Command	6.6[b]	1.5	6.7	1.3	6.6	1.4
Data	4.7	1.1	4.8	1.9	4.8	1.5
File	5.7	1.4	5.5	1.7	5.6	1.5
Program	4.6	1.4	4.8	1.7	4.6	1.5
Language	5.5	1.4	5.3	1.2	5.4	1.3
Total	5.4	1.0	5.4	1.0	5.4	1.0
Attitude						
Anxiety	30.1[c]	5.7	30.9	3.8	30.4	4.9
Confidence	32.4	5.1	33.6	4.2	33.0	4.7
Liking	29.5	8.3	32.5	4.6	30.9	6.9

findings require more evaluation.

Conclusion

Previous studies have discussed the possible influences of types of computers on students' writing (Halio, 1990; Kaplan & Moulthrop, 1990; Levy, 1990; Slatin, 1990; Youra, 1990) and laboratory applications (Williams, 1986). The findings from the present study seem not to agree with their view. In order to improve inservice teachers' performance in computer courses and increase their attitudes toward computers, it is perhaps more important and practical for educators to emphasize their instruction more on the teaching materials and instructional strategies rather than focus on the types of computers being used. As an educator in computing, it is important to keep in mind that any educational innovation is just a tool for delivering knowledge. Whether use of one type of educational innovation such as the IBM PC is as efficient or any more efficient for improving students' performance in computer courses than the other type of educational innovation such as the MAC computer is decided by the people who use it, rather than the innovation itself.

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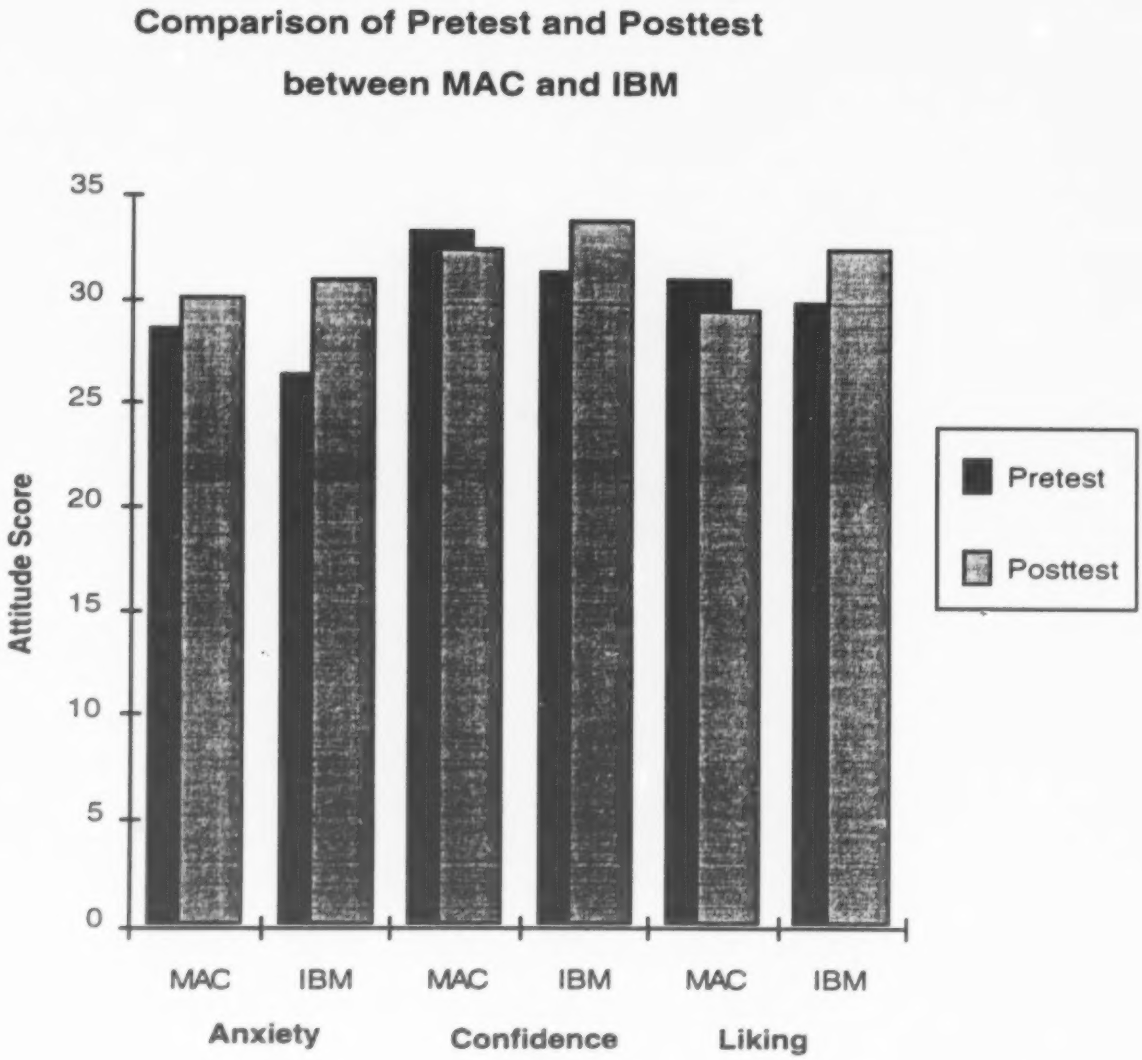
Table 4
Summaries of Two-way ANOVAs for Group by Gender in Posttests

	Source	*df*	MS	*F*
Achievement				
	Group (A)	1	40.46	1.49
	Gender (B)	1	73.86	2.72
	A x B	1	41.68	1.54
	Error	30	27.13	
Misconception				
Command				
	Group	1	0.47	0.23
	Gender	1	0.07	0.04
	A x B	1	0.69	0.34
	Error	30	2.04	
Data				
	Group	1	2.74	1.28
	Gender	1	3.64	1.70
	A x B	1	10.13	4.75*
	Error	30	2.14	
File				
	Group	1	0.01	0.01
	Gender	1	16.47	8.67**
	A x B	1	0.14	0.07
	Error	30	1.90	
Program				
	Group	1	1.54	0.64
	Gender	1	1.11	0.46
	A x B	1	2.57	1.07
	Error	30	2.41	
Language				
	Group	1	0.31	0.17
	Gender	1	0.22	0.12
	A x B	1	0.22	0.12
	Error	30	1.83	
Attitude				
Anxiety				
	Group	1	28.24	1.18
	Gender	1	14.90	0.62
	A x B	1	51.92	2.17
	Error	30	23.93	
Confidence				
	Group	1	28.40	1.27
	Gender	1	27.40	1.23
	A x B	1	16.50	0.74
	Error	30	22.29	
Liking				
	Group	1	89.10	1.83
	Gender	1	0.75	0.02
	A x B	1	19.44	0.40
	Error	30	48.61	

* $P < .05$ ** $P < .01$

Table 5
Means of the Posttest for Group by Gender

Group				
Dependent Variables		MAC	IBM	Total
Achievement				
	Male	22.71[a] (*N* = 7)	22.75 (*N* = 4)	22.73 (*N* = 11)
	Female	21.91 (*N* = 11)	17.08 (*N* = 12)	19.39 (*N* = 23)
	Total	22.22 (*N* = 18)	18.5 (*N* = 16)	20.47 (*N* = 34)
Misconception				
Command				
	Male	6.43[b]	7.00	6.64
	Female	6.64	6.58	6.61
	Total	6.56	6.69	6.62
Data				
	Male	4.43	6.25	5.09
	Female	4.91	4.33	4.61
	Total	4.72	4.81	4.77
File				
	Male	6.57	6.75	6.64
	Female	5.18	5.08	5.62
	Total	5.72	5.50	5.62
Program				
	Male	4.43	5.50	4.82
	Female	4.64	4.50	4.57
	Total	4.56	4.75	4.65
Language				
	Male	5.29	5.25	5.27
	Female	5.64	5.25	5.44
	Total	5.50	5.25	5.38
Misconception Total				
	Male	5.43	6.15	5.69
	Female	5.40	5.15	5.27
	Total	5.41	5.40	5.41
Attitude				
Anxiety				
	Male	29.29[c]	34.00	31.00
	Female	30.55	29.84	30.17
	Total	30.06	30.88	30.44
Confidence				
	Male	32.71	36.25	34.00
	Female	32.27	32.75	32.52
	Total	32.44	33.63	33.00
Liking				
	Male	28.29	33.50	30.18
	Female	30.27	32.17	31.26
	Total	29.50	32.50	30.91
Attitude Total				
	Male	30.10	34.58	31.73
	Female	31.03	31.58	31.32
	Total	30.67	32.33	31.45



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Linkway Live!: A Planning Tool For Reaching Consensus

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A unique, interactive, multimedia application of Linkway Live! was used as a planning tool in a qualitative research project to reach consensus about powerful learning experiences. Public school teachers, home school parents, and church Sunday school teachers attended a training workshop and identified: (a)personal examples of powerful learning experiences; (b)reasons why their learning experiences were powerful; (c)major barriers to experiencing powerful learning; and (d)practical strategies for overcoming the barriers. Interactive screens were used to record and analyze information communicated orally by each of the teachers at the workshops. Several development problems were overcome during the evolution of the Linkway Live! application which included pictures of a real-life powerful learning experience taken on location with a digital camera and captured into the application via Digital Video Interactive (DVI).

Teachers, Interactive Multimedia, and Planning

One thing is certain about the education profession today: it is changing dramatically, creating new and exciting opportunities for educators to expand their influence. Teachers are becoming more involved in the school and community as leaders of instructional teams, school-based decision-making teams, and as leaders in curriculum development. Within these new opportunities, can interactive multimedia help teachers plan for change?

Teachers

A teacher must be a "planner who develops methods to implement a vision of the future in order to prepare students for life in the 21st century." (Chan, Fortunato, Holte, Morse, November, 1988, p. 10). This type of planning requires that our educational system be:

> less hierarchical and more integrated; a system which takes full advantage of a wide spectrum of technologies... curriculum content and processes that more accurately reflect the complexity of today's world and how human beings learn and function... conditions and structures in which individuals can design, experiment, develop, test, and innovate (Ray, 1989, pp. 8-9)

Within this new structure, teachers have exciting opportunities to impact curriculum in the classroom (Monson & Monson, 1993, p. 19).

Interactive Multimedia

Because multimedia interacts with our natural senses it can be "more intuitive, more spontaneous, and even more fun" (IBM, 1992, p.3). Park and Hannafin (1993, p. 81) suggest that "designers must expand their perspective to consider teaching and learning methods and models heretofore unfeasible or unavailable... and identify the implications of the principles and heuristics for interactive multimedia." With interactive multimedia, "related prior knowledge is the single most powerful influence in mediating subsequent learning...new knowledge becomes increasingly meaningful when integrated with existing knowledge"

(Park and Hannafin, 1993, p. 68). These principles also apply when using interactive multimedia for planning.

Planning

The "key to success in all education reform is coalition-building through consensus and critical ingredients of the success include the development of a broad vision...practical objectives to be achieved and practical actions to be taken" (Cortines, 1993, p. 10). Interactive multimedia applications can help teachers reach consensus and develop strategies to transform their visions into reality. However, teachers must remember that "multimedia represents a fundamental shift in how we have processed, communicated, received, and thought about information" (Floyd, 1991, p. x). The principles of "sandbox (a multimedia environment), dirty learning (total emotional and physical immersion), and mucking around (no ulterior correct way in mind) are keys to effective learning in all levels of education from kindergarten through teacher inservice," (Ferris and Roberts, 1989, p. 18) and teachers must find ways to incorporate these keys when using multimedia applications in the planning process.

Purpose of the Project

The purpose of this research project was to investigate the effectiveness of Linkway Live! as a planning tool for teachers. Qualitative research methods used in this project are "considered more amenable to the diversity of 'multiple realities' one finds in a complex field situation" (Borg & Gall, 1989, p. 385). Data were gathered without a preconceived theory with the intent that grounded theories emerge as the project progresses (Borg & Gall, 1989, p. 386).

Method

No preconceived theories or hypotheses were proposed with the intention that grounded theories about multimedia applications in the planning process and powerful learning experiences would emerge as the project progressed.

Subjects

Participants in the project were either K-12 public school teachers (29) or parents who home schooled their children and/or taught in a church Sunday school program (10). All 39 participants volunteered to attend a workshop in which the project was conducted. The K-12 teachers attended one workshop, and the home school and church school teachers attended another workshop. Approximately 75 percent of the participants were female and no participant had less than 3 years of teaching experience.

The K-12 workshop was part of a summer training institute curriculum for public school teachers who were interested in learning how to integrate technology into their curricula. Participants in the home school and church school workshop were invited to attend by church leaders for the purpose of improving home school and church school instruction.

Specialized Equipment

Initially, a HyperCard folder was displayed using a Macintosh computer and a color LCD panel. However, as the project progressed the application was replaced with a Linkway Live! folder which was displayed using an IBM multimedia computer and a color LCD panel.

Procedure

The procedure consisted of seven steps: (1)The participants were informed that they would work together to describe the characteristics of a powerful learning experience, identify barriers to powerful learning experiences, and develop strategies to overcome the barriers; (2)A powerful learning experience was defined as an experience which produced new knowledge with a lasting positive impact on the participants and which could be recalled in great detail; (3)The participants were told to begin thinking about one of their powerful learning experiences while pictures of a real-life powerful learning experience taken on location with a digital camera were shown. The pictures related a story about how an encounter with a poisonous snake caused a local fisherman to discontinue wading the shores of a favorite lake and build a small fishing boat; (4)The participants were asked to communicate orally a one or two word title for their most powerful learning experience and briefly describe the experience. Their responses were recorded on a folder page via the keyboard; (5)The participants were asked to communicate orally two or three words that best described why their experiences were so powerful. Their responses were recorded on a folder page and then discussed; (6)The participants were asked to work in small groups to identify barriers to powerful learning experiences and strategies for overcoming the barriers. Results were shared and discussed among the participants; and (7)The core principles of Foxfire (Ruff, 1992, pp. 4-5) and the philosophy of Critical Teaching (Perkinson, 1993, pp. 34-46) were reviewed by the participants within the context of their collective definition of a powerful learning experience.

Results

The results of this qualitative research project can be looked at by considering the experiences, reasons, barriers, strategies and reactions of the participants.

Experiences

Table 1 contains a list of the words which the participants used to title their powerful learning experiences.

Table 1
Powerful Learning Experiences of Workshop Participants

K-12 Teachers		Home School/Church Teachers	
Turtle	Clay sculpture	Book	Choral festival
Skydive	Duck's operation	Illness	Giving birth
Fire	Sunscreen	Angel	Moving to CA
Science	Coral reef	Library	Dad's death
Tornado	Softball	Sick child	School board
Bottle	Childbirth	Cat	Home Ec. class
Snake	Ducklings	Nun	Family trip
Poem	Observation	Transition	Car repair
Soap	Virginia	Decorator	Drama class
Parenting	Teddy bear	Healed marriage	

Reasons

Table 2 contains a composite list of words that the participants in both workshops used to explain why their experiences were so powerful.

Table 2
Reasons Why The Participants' Experiences Were So Powerful

Survival	Trust	Role model
Safe Values	Caring	Lasting impact
Open door	Emotions	Mistakes
New	Necessary	Accomplishment
Patience	Continuous	Gratifying
Revelation	Relevant	Demanding
Practical	Friends	Self-discovery
Faith	Useful	

Barriers

There was consensus among the K-12 workshop participants that the major barrier to powerful learning experiences in the public schools is the requirement that teachers teach and students master specific knowledge and skills in designated subject areas. The major barrier cited by the home school and church school teachers was the lack of teacher training and motivation. Other barriers cited during both workshops were the lack of parental or custodial support, lack of quality resources because of inadequate financial support, and the wide range of students' individual needs.

Strategies

To overcome the barrier of required subject matter, the K-12 teachers agreed that the best strategy is to somehow "make the students think they are having fun while they are learning the subject matter." Their strategy focused primarily upon the student.

The home school and church school teachers agreed that more teacher training opportunities and planning sessions would be helpful strategies. They focused primarily upon improving their skills as teachers through additional training and peer encouragement.

Participants in both workshops agreed that parents and guardians need to become more involved in the education process. They also agreed that increased financial support is needed.

Participant Reactions

Participants in both workshops expressed approval of interactive multimedia as a planning tool. One evidence of the effectiveness of interactive multimedia was the degree to which participants were able to recall workshop outcomes. Several months after the workshops were conducted participants were able to quickly and accurately recall their lists of experiences, barriers, and strategies during informal discussions about the workshops.

Only one of the K-12 teachers initiated a follow-up request regarding the workshop and that was to ask for a copy of the plans from which the fisherman built the boat. However, several of the home school and church school teachers requested that the workshop be repeated for their colleagues who could not attend.

Discussion

Project participants were able to identify the characteristics of a powerful learning experience and to determine strategies for overcoming barriers to powerful learning experiences. Although Floyd (1991, p. 233) categorized multimedia applications into the areas of public access, merchandising, education, and training, the results of this project support the use of multimedia applications as planning tools.

Although Linkway Live! provided "object oriented programming, accessibility to normal folks, interactive graphics and text, and the rest of the inventory of features necessary to enable hypermedia on the PC," (Harrington, Fancher, & Black, 1990, p. 321) problems were encountered with it during the project.

Problems Encountered

Linkway Live! has the advantages of blank screen pages upon which to work (no menu bars or folder titles), a DVI capture routine that compresses graphics, easily edited page items, and a runtime version that may be stored with the application on a single diskette. However, it has one major disadvantage. Graphics captured with the Linkway Live! DVI routines are stored in compressed files that have an atypical file extension (.AVP). The use of these DVI files in a runtime version of Linkway Live! requires that the DVI capture card be present. The DVI files cannot be converted to more typical graphic formats by using conversion routines supplied with Linkway Live! or by using other common graphics conversion programs. The problem may be circumvented by using a more common capture program which produces picture files in a common graphic format. The problem then becomes the storage requirements for the graphics in typical formats, i.e. a single runtime version diskette cannot hold the Linkway Live! application and the graphic files.

Another problem encountered was that Linkway Live! folders must be stored in either a development format (changes can be made) or a read-only format (changes cannot be made). The only way to input text during planning sessions is to use the folder in a development format which requires double-clicking of the mouse and places dotted lines around the page item used. The application cannot be used in the runtime version because the runtime version automatically puts the application in a read-only format.

Implications

Interactive multimedia can be an effective planning tool to help teachers reach consensus about educational issues such as how to help students have powerful learning experiences. However, Linkway Live! applications for planning purposes could be more "user friendly" if the DVI capture routine permitted storage of captured graphics in the standard Linkway Live! formats (e.g. .PCV) and if information could be entered as text on a page in a full-screen edit mode without double-clicking the mouse.

Further Research and Development

Quantitative research regarding the cognitive and affective impacts of interactive multimedia when used as a planning tool is necessary to more accurately estimate the effectiveness of this type of application. Teachers and administrators need an Internet site designated as a repository for Linkway Live! folders that have been successfully used for planning purposes so that they may share their development questions and applications.

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Integrating Theory and Practice: Multimedia and Graduate Teacher Education

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The role of technology in the schools has changed a great deal over the last decade. The change is due to hardware and software developments in the technologies available to, and being used by the schools. We are witnessing the emergence of interactive instructional computing and it is the most powerful technology ever used in education.

The Challenge to Graduate Teacher Education

Graduate education programs are faced with the challenge of preparing teachers for an increasingly complex instructional environment. Reduction in economic support and resources, the under prepared student, and the increasing recognition of diverse learning styles are just a few of the realities that today's teachers will encounter. In addition, the current climate of educational reform will require that educators accept much more responsibility and a higher level of accountability for instructional outcomes. Administrators and parents are requesting more technology for students to use, but the presence of technology alone does not insure learning; rather what is crucial is effectively incorporating technology into the learning environment.

To prepare new or experienced teachers for these challenging environments, graduate education programs are reassessing the skills that teachers need and are adapting their curricula accordingly. At Philadelphia College of Textiles and Science program in Instructional Technology, we believe the following skills are critical for today's teachers:

1. Ability to analyze the learner, the specific educational environment, instructional content and outcomes desired.
2. Understanding of various learning theories and the effective integration of theory and practice.
3. Familiarity with new and emerging technologies for learning.
4. Ability to design, develop and evaluate interactive technologies.
5. Familiarity with the purpose of educational research in the field of instructional technology and its implications for classroom teachers.
6. Preparation for work within a field that is rapidly and constantly evolving.

The Challenge of Multimedia Technology

The emergence of multimedia technologies has had a profound effect on the educational profession and the professional educator. The computer is no longer only a "tool" for making mundane tasks more manageable; it has introduced a new paradigm for learning. By including the design, development and evaluation of multimedia (the ability of the computer to combine text, graphics, video and sound within a single medium) in their curricula, graduate programs can prepare teachers to evaluate, integrate and even produce effective and efficient multimedia instruction.

Interactive multimedia applications are now capable of the incorporation of sound, moving and still images, text, graphics and animation. Visual computing environments now allow for the combination of extant and emerging media such as CD-ROM, CDI, the graphic digitizer, the read-write optical disc, and digital and analog video. This innovative mixing of text, audio and visuals allows learners to explore and integrate vast libraries of information.

For educators responsible for designing and/or selecting materials for teaching, the task now involves the following: (1) selecting the most effective media with which to convey specific forms of information; and (2) harnessing the pedagogical power of each of these media while at the same time ensuring an educational experience that provides efficient and effective learning. In addition, innovative authoring tools (e.g., HyperCard, Toolbook, Authorware Professional) offer non-programmers access to techniques of creating multimedia instruction that were heretofore only available to technical "experts" in computer programming. In addition, the notion of easily and accessibly linking data provides new methods of structuring information—which requires a more diverse and sophisticated understanding of the human processes of learning.

The complexity of multimedia technologies has also precipitated a role change for the learner in instruction. With more power in the hands of the learner, he or she may now exercise options of choice not heretofore possible. To anticipate these learner choices, educators must recognize and investigate the varied and diverse learning styles present in any target audience; educate themselves about the formal elements of various media, as well as each media's instructional potential; and select those instructional strategies and options that are effective for diverse learning styles.

Ambron and Hooper (1988) compare the proliferation of interactive multimedia instruction to the effect that Galileo's discovery had on his world:

> Fifteenth-century Europeans "knew" that the sky was made of a closed, concentric crystal sphere, rotating around a central earth, and carrying the stars and planets. This "knowledge" structured everything they did and thought, because it told them the truth. Then Galileo's telescope changed the truth.

Galileo's discovery precipitated a transformation of knowledge, and provided humanity with a new lens through which to view the world. Similarly, the extraordinary developments in multimedia technologies in recent years has furnished education with a new lens through which to examine learning. Interactive multimedia provides educators with new ways of analyzing knowledge and new insights into educating learners. In effect, the very methods of structuring educational experiences are being altered.

Multimedia instruction can empower teachers by providing learning environments that are more individualized and that can be monitored and adjusted to meet learner needs. The potential of multimedia to address varied learning modalities by making use of a wide spectrum of media also provides teachers with more options for addressing those modalities through both the presentation and delivery of instruction.

After conducting a review of related literature and attending several national and local conferences, several pertinent themes have emerged. These include: (1) the pace of technological change is rapid and unending; (2) graduate education programs need to change in order to play a major role in the educating and training of students for a technological society; and (3) emerging technologies can provide both the foundation and the impetus that are needed to teach and train today's students to be tomorrow's educators. In order to respond to these themes, graduate education programs must face several challenges, including:

- Providing current hardware and software resources
- Adapting curricula to multimedia technologies
- Attracting qualified faculty to teach multimedia related courses
- Providing students with multimedia-appropriate design, development and evaluation skills

In the Instructional Technology program at Philadelphia College of Textiles and Science, we have taken several steps to meet the above challenges. These are described in the next section.

M.S. in Instructional Technology

In the M. S. in Instructional Technology program at PCT&S, we take a blended approach to technology and teacher education. The emphasis is on the design, development, and production of computer-based interactive technology in education and training. Students take both theoretical and practical, or "hands-on" courses. Among the "hands-on" courses, students can select from either PC or Macintosh-based resources to experiment with such popular authoring tools as HyperCard, Toolbook and Authorware Professional.

Required courses include Fundamentals of Instructional Design; Research in Instructional Technology; and Application Software. In the Interactive Media I class, also required, students work with a variety of technologies including video discs, CD ROM, Mac Recorders, as well as color scanners, and digitizers. The purpose of this class is to demystify the technology as well as the jargon associated with it. Students learn how to capture video, pull it into a computer program and edit the video and audio portions of the program. In addition, course objectives require that students develop a rationale and budget plan for the purchase and implementation of interactive technologies, configure and set up an interactive media station; and develop lesson plans for integrating interactive media into existing areas of the curriculum.

The Design and Development of Computer-Based Instruction and the Interactive Media II class are the consecutive capstone classes for the program. The former flows into the latter as students put into practice what they have learned throughout the program. Students work in design teams and have the opportunity to work with local companies who have entered into partnerships with the College to produce specific instructional materials. We have found that this combination of actual "hands-on" experiences provides an excellent foundation for understanding the design, development and implementation of multimedia instruction for both schools and industry.

Discussion of student-produced programs

Because PCT&S students actually produce multimedia instruction as part of their course work, we have visual proof that the combination of theoretical and practical courses is particularly effective. To date, graduate students have produced HyperCard, Toolbook and Authorware Professional programs on such topics as: Introductory French and Spanish; Teaching the Effects of Prejudice Using the Holocaust; Total Quality Management, Introduction to Educational Technologies; Musical Instruments, Photography, and Driver Training Skills. We have found these programs to be exceptionally well-design and developed, and some students have been nationally-recognized for their multimedia programs through conferences and publications.

Conclusion

Over the centuries, the core of what we teach in our colleges and universities has changed dramatically. But the ongoing process has been a slow evolution (Seymour, 1988). Graduate education programs must respond the changing needs of society. Technology changes too rapidly for these programs to adopt a wait and see stance.

Philadelphia College of Textiles and Science has taken a leadership posture in the development of programs and policies that foster excellence in teaching. Clearly, change must occur within our educational system to insure that we prepare students for the 21st century. A critical piece of the educational system are graduate education programs. Therefore, these programs must respond to the challenges of today's society by providing teachers with the skills necessary to confront diverse student populations and an increasingly technologically-dependent society. We believe the approach taken at Philadelphia College of Textiles and Science can serve as a model for other programs to adopt or adapt as they attempt to change their approach to teacher education.

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Special Educationl Inservice Training in Correctional Centers via Audio and Computer Conferencing.

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The College of Education at the University of New Mexico (UNM), through its Divisions of Learning and Teaching (Special Education), and Innovations in Education (Distance Education), is collaborating with the New Mexico State Departments of Adult Corrections, Education, and Children, Youth, and Families to address the timely issue of special education personnel development in New Mexico's juvenile and adult correctional facilities. The product of this collaboration is a pilot study comparing the effectiveness of audio and computer conferencing in the delivery of special education training to educators in correctional facilities. This study examines how two different interactive telecommunication strategies—synchronous audio-conferences and asynchronous computer conferences—manage the delivery of a field-based special education course employing collaborative and individual problem solving assignments. The course is being delivered into 18 correctional facilities in New Mexico, seven facilities receiving the course over audio conference, eleven over the computer.

The Problem

The prevalence of individuals with disabilities may be as high as three times greater in United States prisons than among our general population (Keilitz and Casey, 1988 and Snow and Briar, 1990). Currently, the correctional institutions in the United States serve a collective population of some 1.1 million men, women, and children. In addition to those incarcerated, nearly 3.5 million persons are under community supervision. Within the incarcerated population alone, more than 400,000 (40%) are believed to suffer from some handicapping condition (Coffey, 1983). In 1987, a review of the literature by the Institute on Mental Disability and the Law suggested that approximately 50% of the youths in correctional settings have a disability that may qualify them for special education services (Power-Cluver and Yaryan, 1992). In 1991, Rutherford indicated that nationally, 40 to 60 percent of juveniles in correctional facilities received special education when enrolled in public schools.

Research continues to confirm education as the most economical rehabilitation tool available for *all* individuals in correctional institutions (Brown, 1990; Fink, 1991). Men, women, and youth whose educational programs enable them to attain employment or seek further training are less likely to recidivate and are better equipped to advocate for themselves and contribute to the lives of their families (Lanier, Philliber, and Philliber, 1991). The Individuals with Disabilities Education Act (IDEA), mandates individualized and appropriate education for all students with disabilities through age 21, even when they are imprisoned. Section 504 of the Vocational Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 prohibits discrimination based on a disability for individuals of all ages.

However, most of the adult inmates needing special education are not served at all; juveniles, if they are served, receive only marginal or inadequate services (Rutherford, Nelson, and Wolford, 1985). Only five states claim partial compliance with the law in their correctional facilities (Eggleston, 1990).

One major stumbling block in implementing the Education for All Handicapped Children Act (P.L. 94-142) in correctional settings has been the difficulty in finding and hiring qualified special educators (Leone, 1986). Recent data indicates that there is less than one special education professional per correctional institution in this country. Unfortunately, special education teacher shortages are not confined to correctional facilities. There is a critical shortage of special education teachers in rural and remote regions all over the United States. In New Mexico for example, nearly 500 teachers hold emergency certificates or teaching waivers, thus comprising a significant proportion of service delivery in the field. These professionals must complete at least nine credit hours of course work per year to retain their positions, a difficult task in isolated areas far from colleges or universities. This shortage of specialists exacerbates the dilemma of finding and hiring special educators to work in correctional facilities. It seems more realistic to offer training to the professionals already working in the correctional facilities, many of whom have already expressed great interest in special education training.

Prison facilities in New Mexico are spread across wide geographical areas, frequently in isolated rural settings. Educators in these correctional settings have very few opportunities to share their classroom expertise or concerns with one another, have limited access to educational and/or resource centers and materials, and have needs unique to their settings. The difficulties recruiting and retaining educators in rural and isolated facilities and the need to continuously upgrade teachers' skills require a radical change in the way teacher training is conducted. Teachers are generally asked to travel to university centers at night after a full day's work, participate in one or two day workshops, or relocate for one-week summer intensives. Once on campus, teachers typically lose their professional status and are, as students, inundated with ideas, materials, and suggestions for later application in their classrooms. Often what they learn is not applicable to their actual work settings.

Professionals would be better served if training and information were delivered directly into their workplace and generated participant input. Research has shown that when learners are respected and brought in on the design and evaluation of the training, their approach to the content and consequent assimilation of the material is enhanced (Henri, 1992). Distance education technology is a viable means for the group design and delivery of teacher training and information transfer. In 1991, Knapczyk espoused collaborative learning supported by teleconferencing as an effective method of personnel development in rural and isolated settings. The research conducted by Kirby and Boak (1987) and Hiltz (1990), demonstrates audio and computer conferencing's ability to allow a collaborative process where the knowledge and experience of learners are incorporated in the design and training. However, the ability of audio and computer conferencing to allow for interaction and networking does not necessarily suggest that "learning" will be automatic. Carefully planned training and assignments are essential to enable interactive group structure and facilitate learning in a collaborative mode.

Hiltz (1988) describes the essence of collaborative learning as knowledge that emerges from active dialogue among those who are seeking to understand and apply concepts and techniques. Access to teleconferencing at the jobsite increases learning potential. Answers acquired through conferencing, can be immediately applied in the work situation that houses the problem. Through the exchange of practical strategies and discourse with peers, instructors, and mentors, participants become actively involved in a dynamic and growing course content.

Course Description

A course entitled "Teaching the Special Needs Learner in Correctional Education," was designed by the author and Dr. Eggleston (a Correctional/Special Educator from California State University San Bernadino) specifically for correctional educators, using teleconferencing technology. The author and Dr. Eggleston are team-teaching the course electronically from New Mexico and California respectively. Electronic staff classrooms have been established in 18 of New Mexico's Correctional Facilities, including all the adult prisons (male and female), juvenile detention centers, county jails, public school detention homes, juvenile and adult diagnostic and development centers, a psychiatric treatment center, and the Department of Corrections' training academy.

The course is being offered for graduate or undergraduate credit (3 credit hours) and will last one semester. The objective of the course is to offer correctional educators an opportunity to: try out special education classroom strategies; develop a deeper awareness/understanding of the nature of disabilities; form a network of colleagues, mentors, and field experts; and interact with other agencies in order to more successfully impact the education/rehabilitation of their students. The course is scheduled to run for twelve weeks. The first two weeks of the course are dedicated to learning the conferencing technology. Participants, both on the audio and computer systems, join mock conferences, set up their own conferences, and send messages electronically. The third week of the class is directed at the legal issues and laws concerning individuals with disabilities and the difficulties of implementing special education in the correctional facilities. The remaining nine weeks are divided equally into the following disability categories: mental illness, mental retardation, and learning disabilities.

The correctional educators in both the juvenile and adult facilities receive the course during the regular work day as part of their scheduled preparation period. The participants are also welcome to conference on their own time whenever convenient. Access to the instructors, colleagues, technical support, and experts in the field occurs entirely over audio or computer conference. Participants will have continuous access via conference to the course instructors, their colleagues, mentor teachers, and field experts from around the state of New Mexico.

Collaboration occurs in small groups within the facilities and among colleagues at distant sites (e.g., educators at the women's prison collaborating with colleagues at the girl's juvenile center) via conferencing technology. Participants conference with mentor teachers and field experts, independent of their instructors, in order to solve problems and complete assignments (e.g., educators at the jail and educators at the psychiatric treatment center conferencing with a field expert on Fetal Alcohol Syndrome). Students have continuous access to a technical support team (an information analyst/librarian from Hamilton, New York, two student assistants from the departments of Criminology and Training and Learning Technologies at UNM, and a high school student with computer expertise from Albuquerque High School). Mentor teachers and field experts have been solicited from the fields of Special Education, Vocational Rehabilitation, Mental Health, Criminal Justice, Correctional Education, Public Health, and Developmental Disabilities.

Prior to the start of the course, the author/instructor traveled to each of the 18 sites in order to install and test the conferencing equipment, administered a pretest of special education competencies, trained the participants on how to use the conferencing equipment, demonstrated how to problem solve collaboratively, and solicited from the participants a hierarchy of their training needs. Six months prior to the course delivery, the University of New Mexico hosted a two-day training session for the correctional educators. On the first day the educators met the two instructors face-to-face and learned about the format/content of the course. On the second day they were given e-mail accounts and an introduction to the Internet. A survey conducted at this time generated the following areas of concern: traumatic brain injury, attention deficit disorder, conduct disorder, fetal alcohol syndrome, substance abuse, mental illness, mental retardation, communication disorders, learning problems, and infectious diseases. All participating sites received a printed text, "Special Education in the Criminal Justice System," and a study guide containing course assignments. The study guide, in a three-ring binder, contains a week-by-week description of the course development. This study guide is purposely designed as a "shell" providing the core of the curriculum while remaining open for expansion, allowing the participants to direct their training as the conferences progress.

The guide is written in conversational style and contains the syllabus, participant introductions (including the technical support team and field experts), photos of all participants, readings, assignments, and the audio or computer conferencing manual. The author, with the assistance of the technical support team, created audio and computer conferencing manuals describing how participants and instructors can use the technology to access the course content and maximize its potential.

Audio Conferences

Seven sites are receiving the course over audio conference and are equipped with speaker phones, facsimile, and answering machines. All audio conference bridges are supported by *Preferred Communications* , selected for its myriad services: ongoing training and support, pre-notification, taping of conferences (allowing for transcript analysis), continuous monitoring, and subconferencing (allowing participants to break into teams or small groups with an operator standing by). Participants are asked to fax to their colleagues a brief biography. The course focuses on three disability areas: mental retardation, mental illness, and learning disabilities. Three weeks are dedicated to each of these areas. On Monday of each week, at a designated time throughout the duration of the course, a formal one-hour conference between the instructors and the participants is conducted. The instructors conference for one hour with 4 sites, disconnect, then establish a conference with the remaining 3 sites. These conferences center around a set topic but may take many different forms (lecture, reactor panel, guest speaker, participant presentation etc.). During the first week, participants discuss the disability topic for approximately 20 minutes (discussion based on readings or previous experience), go offline for 15 minutes to perform an associated activity, come back on to discuss the activity, and return online to generate areas of concern, case histories, and prior problems or strategies associated with that disability area. Each participant leaves the conference with an individual assignment (e.g, strategies to try out in their classrooms) and an assignment involving team problem-solving across distant sites, designed to generate better understanding of the disability being studied. Field experts/mentor teachers are assigned or suggested to assist this team problem-solving assignment.

Participants are instructed to try out the classroom strategies with their students and send a short reaction on the success or failure of the suggested classroom strategies via facsimile to their instructors. They also prepare to discuss the results of the individual assignment on Monday of the second week. Participants are instructed to collaborate with their teammates (onsite and distance) and field experts initiating their own independent audio conferences. Solutions to the problem and information on the disability gleaned during the independent conference calls, was edited and distributed by the team and sent via facsimile to all participants. Teams led the formal one-hour Monday conference call on the third week, sharing with the entire group the information they discovered.

Computer Conferences

Eleven sites are receiving the course via computer conference and are equipped with PC's containing word processing, communications and conferencing software. The conferencing software, *CoSy*, was chosen for its ease of use by computer novices and its ability to allow group problem solving.

The following conferences have been created inside the conferencing software: Syllabus, Cafe', Introductions, Technical Help, Weekly Topic, Individual Assignments, and Team Assignments. On Monday , week one, the instructor types into the Weekly Topics conference details of the disability under discussion. Participants are directed to open this conference, carry out associated activities, and generate areas of concern, case histories, and prior problems or strategies associated with that disability area. There are no time constraints in asynchronous computer conferencing. Participants have continuous access to the Weekly Topic conference and leave the conference with an individual assignment (e.g., strategies to try out in their classrooms) and an assignment involving teams group problem-solving across distant sites to generate better understanding of the particular disability being studied. Field expert/mentor teachers will be assigned or suggested to assist with this assignment.

Assignments on the computer conference are identical to the audio conference; however, computer participants are instructed to collaborate with their team mates and field experts inside *CoSy* in conferences labeled Team Assignment, and/or create and moderate their own conferences. Solutions to the problem and information on the disability gleaned during the conferences are edited and distributed by the team or group and sent via e-mail to all participants (post delivery is acceptable). Similar to the audio conference, computer conferencing teams lead the conference labeled, Weekly Topic on Monday of the third week, sharing with the entire group the information they discovered.

Research

Pre and post tests, questionnaires, group interviews, a learning styles inventory, and transcript analysis are being used to determine the effectiveness of the audio and computer conferences in delivering special education inservice training into the correctional facilities. In addition to mastery of concepts, as demonstrated on a course grade, participants will be administered pre and post tests to ascertain whether they have an increased knowledge base, are able to apply the material of the course in new contexts, express their own independent ideas, and synthesize the information. Participants' attitudes concerning collaborative learning assignments and the outcomes of the assignments will be matched to participants' learning styles.

The transcripts of both the audio and computer conferences will be carefully analyzed, focusing on the learning process as revealed in the conference messages. Five dimensions of the learning processes will be highlighted: participation, interaction, socialization, cognition, and metacognition. The computer conferencing transcripts will be analyzed using software designed by Dr. Henri at the TeleUniversite in Montreal, Canada. Group interviews will be used in order to solicit open, spontaneous, participant-led discussion.

Afterword

In 1973, Wedemeyer stated that people should not be denied the opportunity to learn because they are poor, geographically isolated, in poor health, socially disadvantaged, institutionalized, or otherwise unable to place themselves within the institution's setting. Before correctional educators can offer educational access to incarcerated students with disabilities, they themselves need information and training.

Audio and computer conferencing can offer critically needed inservice training to all isolated educators while affording them an opportunity to interact *locally* and *nationally* with instructors, colleagues, databases, library resources, and educational centers. The technology we choose for distance education and workplace training will serve our educational needs only when we understand how to utilize it to its maximum capacity. We need to understand our audience and the abilities of our instructors, and work together to consider the critical elements of the learning process as we design future teacher training.

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A Low-cost Approach to Teacher Preparation at a Distance with Audiographic Technology

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Distance education offers an exciting means of providing training to teachers in rural areas (Knapczyk, 1991; Knapczyk, Brush, Rodes, & Marche', 1993). But discussions of distance education too often focus on rapidly developing high-end technologies, with their astonishing promise for future communication—and their even more astonishing price tags. In the excitement over new technological achievements, we often lose sight of the more practical issue of how to develop a workable model for distance education in the present times of tight budgets and limited resources. We may forget that the quality of distance education depends less on the sophistication of the technology employed than on the skillful harnessing of available resources—both technical and human (Keegan, 1990). To be successful, inservice instruction must be based on the practical application of technology to teacher education, and on the cooperation of universities and school corporations in offering field-based courses and practicum experiences.

For the past five years, Indiana University has been offering inservice course work through distance education and interactive communication technology at an expense comparable to the cost of traditional campus-based instruction (Knapczyk, Brush, Champion, Hubbard, & Rodes, 1992). In this paper, we will discuss some guidelines, drawn from our experiences, for choosing appropriate technology and for structuring field-based training.

A low-cost option for distance education technology

The cost of distance education is a major consideration in selecting an approach to use, because of the limited resources universities and school corporations have for field-based teacher preparation. In our program we use basic, low-cost, reliable technologies to deliver weekly classes to remote sites, typically in local high school libraries or meeting areas. Each hardware and software component fulfills specific roles in course delivery. We will discuss each element in turn:

Speaker phones

Speaker phones provide our basic communications link with teachers during the class sessions. Speaker phones are relatively inexpensive and can be used virtually anywhere, and the teachers adapt quite readily to them because they are so familiar. We use the AT&T Quorum telephone system, which supports an excellent omnidirectional microphone and a fairly clear speaker, two elements that are crucial for effective communication. While ordinary speaker phones are sufficient for instructing small groups, high-quality microphones and speakers enable us to teach twenty or more teachers in a session. At the originating site, we use operator-style headsets to increase the clarity of the presentations.

Facsimile machines

Facsimile machines permit continuous access and rapid feedback between university instructors and teachers. The teachers complete ongoing practicum work each week, and fax their worksheets to the university before the next class. They also send notes if they need clarification or have special difficulties. The instructors return feedback to the teachers' work sites by fax, enabling the teachers to put any advice or direction into practice immediately. The fax machines are also used at class time to transmit supplemental course materials, instructions for in-class activities, attendance lists and other documents to and from the class site.

Audiographics

Audiographics supplies a visual component during the class. Audiographics is an interactive computer-based technology that allows users to share text and graphic images, and annotate images displayed on monitors or projection devices (Knapczyk, 1990). The system we use consists of the following:

- Macintosh LCII computers at the university and remote sites,
- 9600 bps modems operating over standard telephone lines,
- An n-View LCD overhead projector at each remote site.

We use the computers as a two-way overhead projector or chalkboard to illustrate our presentations, to emphasize important points in a discussion, and to develop an interactive exchange with the teachers at the remote site. To accomplish this, the system employs the following software:

- AppleTalk Remote Access, to establish the communication link between computers through the modems,
- Macintosh Multipoint Interactive Conferencing Application (MacMICA), to create a shared "electronic chalkboard" between the sites,
- Timbuktu, to control the remote computer and to access and configure software applications,
- SuperPaint, to create PCX or PICT images of course material, such as overheads, that are pre-shipped to the remote sites before class time.

This combination of technologies and software allows us to complete any needed class preparation at the origination and remote sites. The instructors and students can simultaneously speak with one another, and see and annotate graphic images of course materials. This entire system can be purchased for about $2500 per site, but most universities and many school corporations already have some of the major components. The only additional costs for operating the system are monthly telephone charges. Comparable software configurations can also be purchased for MS-DOS users.

Tips for technology selection

We have found that the choice of technologies to develop and deliver training through distance education should take into account the following principles:

Use what is available

In the rush to embrace new technologies, educators can easily overlook the usefulness of more commonplace inventions. We discovered, for example, that the speaker phones and fax machines are the most powerful and versatile equipment we have. They can be set up almost anywhere and be used at any time, and they allow a greater and more free-flowing exchange of information, ideas and advice than is typical even in a normal campus class. The fax allows us to send backup copies of class materials and overheads to our sites in case the computer link breaks down during class. Before investing in high-end technologies, then, it is important to explore existing or readily available equipment such as fax machines and telephones.

Choose reliability over sophistication

We also discovered that reliability and consistency are far more crucial than impressive effects when delivering distance instruction. Typically, the most elaborate and sophisticated technologies we have used are the ones most prone to bugs and breakdowns that can quickly erode the confidence and morale of the teachers on site. For example, MacMICA is an invaluable communications tool because it is simple to operate and seldom "crashes", even over the primitive telephone lines and switching devices that often exist in rural settings. These features make it far more valuable than other more powerful products that tend to be less reliable.

Have the goals of the program drive decisions about technology

Before investing in any equipment, it is important to have a very clear idea of what the instruction is to accomplish, what materials will be used, where class sessions will be delivered, what resources are available in the field, and who will be included in the training. Considering these issues carefully before deciding about technology will save a great deal of time and money. In fact, program development is by far the most important part of creating a distance education course, even when working under a generous budget. Establishing clear goals for the program, and treating technological questions as a subordinate issue, ensures that the equipment used and the way in which it is employed will be well suited to the instructors' and teachers' needs.

General principles of program development

Distance education technologies provide the tools for instruction that can be used in many ways and be adapted to suit a wide variety of demands, constraints and circumstances. Instructors and program developers should, however, first decide what outcomes, goals, and objectives they wish to accomplish in the program and course work. The following principles, can be used as general guidelines for structuring course work using distance education (Helge, 1984; Keegan,1990; Treadway, 1984). The course work should:

- offer training that is practical, useful, and oriented to job responsibilities,
- be flexible and address a wide range of individual needs
- assist trainees in the shared development of their own skills and promote ownership in the program,

- offer opportunities to practice and apply skills in realistic circumstances,
- utilize local resources and expertise in program planning and delivery, and
- employ technology effectively and encourage various modes of participation.

These principles can create many unique challenges for course instructors who work with inservice teachers. They also represent unique opportunities, if properly planned for. In the next section, we will discuss three areas in which distance education offers distinct advantages over traditional instruction for addressing the principles described above: (a) promoting ownership through on-site coordination; (b) promoting application of training to on-the-job situations; (c) encouraging collaboration.

Promoting ownership through on-site coordination

One challenge of distance education is handling the logistical and instructional tasks that arise in any normal class session. We have found that these tasks are best carried out by the teachers themselves. Adult learners bring a wealth of professional skill and experience with them to their classes. Properly structured, distance education can capitalize on these experiences in a manner that facilitates the mechanics of course delivery, enriches the content and teaching interactions of the class sessions, and more closely involves teachers in their professional development.

To accomplish these aims, we have two different teachers serve as coordinators for each session. One person coordinates the technical setup of the class by assembling the equipment for class and establishing the voice and computer link-up. As the year progresses, each teacher learns about the technology and becomes comfortable with its operation, thus removing the initial apprehension teachers often have about participating in a distance education activity.

The other coordinator oversees the instructional aspects of the class sessions. This includes passing out papers and working out seating arrangements for small group activities, as well as assisting with the actual course instruction. We prepare the coordinators for these responsibilities by talking with them before the class sessions to explain the topics that will be covered, outline the roles they will serve, and suggest methods for carrying out the duties. This preparation enables coordinators to oversee class discussions, redirect questions back to the group, present examples of course concepts, and explain how procedures and techniques can be used in situations that all the teachers are familiar with. The on-site coordinators personalize the class activities and allow for a fuller consideration of the concepts and techniques covered in the course, thus shifting the responsibility and ownership of the instruction onto the teachers themselves.

Promoting application of instruction to on-the-job situations

In many inservice programs, teachers have very few opportunities to apply the concepts they learn to actual teaching situations until much later in a practicum or student teaching experience. However, learning under "artificial" circumstances is often not very effective because teachers typically have considerable difficulty transferring abstract concepts to real-life job situations.

We offer training for one to two years, and we show the teachers how to fully integrate theoretical concepts into teaching practices that suit their job situations. A prime benefit of providing instruction over a long period is that it allows us to create opportunities for the teachers to practice new methods, to use them in combination with other methods, and to adapt them to fit a variety of teaching contexts and situations. Thus, as teachers learn new teaching skills, they also learn how to put them together with the skills they already have so as to form increasingly complex and unified teaching behavior. The extended training approach allows us to tie the concepts covered in the program directly to the teachers' existing knowledge and skill base. At the same time, the instructors learn increasingly more about the teachers' particular circumstances, and can access technology that permits easy and frequent communication with each teacher.

Encouraging collaboration among teachers

Research has repeatedly shown the value of within-school professional team building and collaboration among teachers (e.g., Thousand & Villa, 1989). However, in traditional models of teacher preparation, strategies for collaboration are usually not built into the instruction. In fact, the design of many teacher education courses discourages, rather then encourages, collaboration among students (Resnick, 1987).

Because our program is field-based, we can attract groups of teachers from the same school or school district, and can incorporate collaborative team building techniques into the very structure of the course work. The course work encourages teachers to share their ideas and build closer professional relationships with one another. Thus, they work with expert mentors that include both the university instructors and other teachers in their school building. We use a variety of in-class activities in which teachers share their experiences and help one another apply and adapt the course concepts to their teaching circumstances.

Out-of-class projects are assigned on a collaborative basis so as to continue this professional dialogue about course topics. The students meet in school-based groups to discuss the concepts presented in the class sessions. Then, they work together to prepare lessons and interventions for the children in their classrooms. By working together, the teachers can access a wealth of expertise, resources, and information that would otherwise remain untapped.

Furthermore, after the yearlong training is completed, the collaborative teams often remain intact, thus providing the teachers with a ongoing peer support structure.

Summary

The key to preparing the teachers of today to carry out their professional responsibilities is not necessarily found in high-priced technologies, but rather in developing a new level of cooperation between universities and public schools and exploring new ways to offer course work. Even at a low cost, distance education and communication technology can help to give teachers access to current information on teaching practices and provide a catalyst for improving the quality of teacher preparation and educational programs for children.

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Love 'em and Leave 'em: A School University Collaboration

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> *Probably nothing within a school has more impact on children, in terms of skills development, self-concept, and classroom behavior, than personal and professional growth of teachers. When teachers individually and collectively examine, question, reflect on their ideals, and develop new practices that lead toward those ideals, the school and its inhabitants are alive. When teachers stop growing, so do their students.*
>
> *Roland Barth, Run School Run p. 147.*

The school district described in this paper, like many other districts, had been adding technology into the schools in an unplanned fashion. And, like many other districts, the time had come to put the pieces in place; to examine what they had and where they wanted to go. The philosophy expressed in the Roland Barth quote accurately describes the culture of the district in which this project took place. Under the leadership of the assistant superintendent for instruction the first steps to develop a technology plan were taken through the creation of a Technology Task Force and the development of a relationship with a computer educator/ consultant from a nearby university. An important second step was the joint planning for an extensive and ongoing staff development program in the area of technology.

Involving teachers in staff development programs, creating a trusting environment for learning where teachers can experiment and take risks, and providing ongoing support and follow-up assistance greatly increases opportunity for long-term changes in teacher behavior (State Board of Education, 1990). Bas-Isaac's (1992) research on staff development provided the guidelines for the development of this project. The guidelines included these five elements which are common to successful staff development programs: 1) organization and development, 2) collegiality, 3) needs assessment and program evaluation, 4) scheduling and participation, and 5) additional support activities. In addition, the staff development workshops emphasized integration of technology into classroom practice because teachers are often more willing to change their teaching strategies when they believe it is of benefit to their students (Bas-Isaac, 1992). This project also reflected what we know about the importance of administrative support and district commitment to ongoing staff development projects (Duttweiler, 1989, Illinois Administrators' Academy, ND).

The Implementation Team

Behind the scenes throughout the two years of this project was what we will refer to as the implementation team. The team was made up of the assistant superintendent, the district technology coordinator, and a faculty member of the Department of Computer Education of National-Louis University. Each of these team members brought different strengths, expertise, and perspectives to this school/university collaborative effort.

The assistant superintendent, Dr. Barbara Unikel, with a background in administration and supervision as well as in curriculum, acted as a liaison to the administration and to the school board. She facilitated all of the details of the staff development program by determining the scheduling, and locations and working with the budget. In addition she co-chaired the technology committee. Dr. Marianne Handler, with a background in computer education and instructional leadership, brought a global perspective on the uses of technology in educational settings, knowledge of research and best practices in the area and an overview of ways in which other local districts were implementing technology plans. Handler worked with the district coordinator, classroom teachers and administrators during this two year process. Ms. Diane Cederlund, the district technology coordinator had a clear picture of what was happening in classrooms in the district and a knowledge of teacher strengths, weaknesses, and attitudes toward becoming involved with technology in their instructional settings. She had the pulse of the faculty. Through her work in each of the buildings she also could identify building hardware, software, and support needs.

Beginning the Process

The team began to work together during the winter of 1991. We met to brainstorm ways in which the district could begin to put a program in place and the different possibilities for providing meaningful staff development options. In January Handler met with the Technology Task Force to develop a technology mission statement for the district. She acted as a facilitator as the group discussed where they had been, and where they were, and helped them to envision what the future could hold. In addition, she worked with them as they came to consensus in the development of the mission statement. Following that meeting the other members of the implementation team worked with the Technology Task Force as they developed a needs assessment for the faculty and began their work in developing a district plan.

Following that initial meeting of the task force, the team planned the staff development program for the 1991 - 1992 school year. In developing the plan the team took into consideration that the members of this predominately mature staff were at varying levels of confidence and expertise but for the most part were at the novice level. They were novices both in the use of the technology and in the ways in which it could be brought into the classroom; for the most part, they were not even personal users. Instructional assistants who staff the building level computer labs would also be encouraged to participate in the workshops.

Building level and central office administrators would be encouraged to join any of the staff development programs that were being offered. At the suggestion of the consultant a separate workshop would be held for principals and central office administration. During this experience they would become aware of the software that was available for integration into curricular projects. It would be an opportunity for them to become aware of the complexity of what teachers were being asked to do. For some administrators it would be the beginning of their own technology awareness education; some had never sat at a Macintosh before, had never used a mouse.

At the district level plans were made for a teacher computer purchase plan which would enable staff members to purchase a computer for their personal use. A computer fair would be held at which teachers could see a variety of computers and determine which best fit their needs. When it was held the next year, a large number of staff took advantage of the computer purchase program. This gave them an opportunity to practice what they were learning in the staff development sessions at their own convenience, at home.

The Staff Development Plan: The First Year

It should be noted that the district offered staff development strands in several instructional areas and teachers were encouraged to select an area of interest and follow it for the entire year. Participation in the staff development program is voluntary. Obstacles to change such collegial isolation, professional isolation, lack of confidence, and fear of failure can defeat efforts toward helping teachers change (Leinwand, 1992). The importance of the year long commitment was the opportunity for peer collaboration during the workshops. Together teachers would become aware of new materials, have a supportive hand nearby and receive encouragement to experiment from colleagues and administrators alike.

Technology would be one of the year long professional development series to be offered. District funds, including state and federal monies, supported the program through payment to the consultant, providing books and other materials needed by the participating teachers and for graduate credit for those who chose that option.

One group of workshops was led by the district computer coordinator and they were for credit on the district salary schedule. The first two workshops of the series dealt with word processing and teacher utilities; the third was an opportunity to use telecommunications. These sessions were geared toward those teachers who had little if any experience with computers but were interested and anxious to become involved. Handler led two other sessions; Getting Acquainted with Hypermedia for district credit and Application Software in the Curriculum for graduate credit at the university.

The administrators' workshop was held early in the school year and accomplished the goals that had been set for it. Administrators worked with ClarisWorks and with KidPix and spent some time exploring HyperCard stacks. They were very much involved and found working with the programs not to be as easy as they might have expected. They did observe that the workshop helped them to focus on teachers uses of the software and on what experiences teachers might have implementing these uses in the classroom.

The Technology Task Force: The First Year

During the first year the Technology Task Force worked with two of the implementation team members to put together the district plan and develop a scope and sequence of student skills. The committee also collected input on the staff development sessions and assessed how things were going for the teachers. They were also exploring new technology activities to bring into their classrooms.

Plans were made for the second year of the project. One major decision was to offer district credit rather than university credit in the technology workshops the next year. In this way the experiences could be better tailored to teachers' needs and the lessening of time requirements would take pressure off the classroom teachers.

In addition, decisions about district hardware purchases were determined. The second year would be the first time that each building would have a computer lab and a full-time resource person to help teachers plan for the use of technology for curriculum connections.

From the computer coordinator's perspective the committee was a key element of the first year of the plan. It provided her with an avenue of communication, a chance "to hear about what we were doing." It was also her opportunity to work with others to begin the process of putting a district program in place.

Continuing Staff Development: The Second Year

A Teacher Request Program was instituted for this year. Teachers could request additional computers for their classroom by describing, on a written application, the ways in which they planned to use the computers in the classroom and how they would evaluate their use. This was geared primarily to the elementary buildings and provided a useful way to move the Apple IIe's from the middle school where Macintosh computers were being purchased for the computer labs.

The implementation team continued to plan together, although not as frequently or in as systematic a fashion as they would have liked. Cederlund continued to work with the next set of 'beginners' while Handler offered workshops for those who had moved further along in their comfort level and desire to use the computers. Several administrators, including Dr. Unikel, participated in these workshops as well. During these last workshops, Handler had the opportunity to move the teachers beyond the computer to examine some of the emerging technologies that can be used in classrooms, such as laser discs and CDs designed for instructional use.

Additional Second Year Factors

Cederlund notes that during the second year two changes became apparent. The first was that district support for technology was clearly emphasized to the teachers. The second was her observation of the expanded ways students were beginning to use computers in their classes.

During the second year Handler became involved in the district in a new role. In connection with her own research on teacher support she became a resource to Cederlund and another teacher as they brought HyperScreen into the curriculum as a student tool. The teacher was a new computer user and her success acted as an impetus for other teachers to become interested. The work of these students was accepted in the Tech2000 presentation at the state capitol. The classroom teacher, the district coordinator and several students went to Springfield representing their school's involvement with technology.

The Third Year

"Love em" is over and "Leave em" is taking place. Handler is still welcome in the district as 'a friendly resource. She continues to spend time in the schools working with teachers on the types of support that are important to them. She is still available to Cederlund as a colleague, a sounding board and a resource. Materials that she brought into the district area are appearing in classroom projects. The district is moving forward to institutionalize the plan they have developed.

The instructional assistants in the computer labs in each building have developed their skills to the point where they are now being paid to lead staff development workshops. New pilot programs have begun in the district. The interest in HyperScreen grew at the elementary level and some of the teachers are receiving help from Cederlund as they begin to develop student designers in classrooms in several schools. Other teachers, again under Cederlund's guidance, are working on ways to bring CD technology into their classrooms while others are working with the National Geographic KidsNet program. The district has purchased Macintosh Powerbooks to be kept on a cart and used in classrooms for group writing projects in the middle school. The collaboration of the implementation team has successfully brought the district to the place where the program will grow to meet the needs of teachers and students.

The Implementation Team Looks Back

In looking back over the two year collaboration, each member of the implementation team reflected on their own personal growth, on what they had given and what they had received during the process and on their plans for the future in relationship to this project. Their collaboration had supported what Rudduck (1992) had found as well. University faculty and key school players, together, can build a secure environment in which new and experienced teachers can feel supported while trying out new ideas. The implementation team was able to send the message that this was a time and place where risk taking was valued.

The Assistant Superintendent

The assistant superintendents' increased knowledge of the role of technology in curriculum and instruction was an important growth element for this member of the team. She learned new skills as a technology user and learned about new software and applications for personal use. She increased her own skills as a committee facilitator and gained satisfaction from helping to bring the area of technology to a new level of awareness and importance in the district. She also helped the district to establish a link to the university and the consultant to assist in developing this project.

Unikel's perceptions of what she brought to the project included proposing to the superintendent the establishment of the Technology Task Force to begin the process of formalizing a technology program and developing a plan. In addition she established the staff development program to meet the needs of staff members at varying levels of expertise; developed with the coordinator; the computer purchase plan, and provided the link between Handler and the district. In her work with the coordinator she actively assumed the role of mentor and provided the support needed for Cederlund as she moved from a classroom teacher's role into a district leadership position.

She gained satisfaction from watching the staff and the administration be receptive to increased attention to the technology area, from observing the coordinator grow in confidence and competence in her new leadership role, and from her own increased knowledge and skills in the area. Her ultimate satisfaction was in knowing that the district students would be provided appropriate opportunities to use technology.

The District Coordinator

Cederlund saw the collaboration as "A critical piece" of the process for her. The ways in which the team respected and trusted each other, "worked", as she says, "in a sense of mutual respect." She saw herself as growing in her ability to take risks. Being involved during these two years had opened new doors for her, allowed her "to do more" and try new things because of the workshops she had taught.

A key element to this program was the extensive support provided by the consultant to the district coordinator throughout the first year, thus making it possible for her to assume a greater leadership role during the second year of workshops. The other members of the implementation team saw Cederlund become a respected resource to her colleagues, become someone teachers viewed as having the information they needed. Unikel observed that there had been a transition from teacher to leader in the coordinator role.

The University Consultant

Handler increased her own skills in working with groups during the two year project. This was particularly true when she worked with the task force on consensus building and when she led the administrative workshop. Because of the time spent in developing the workshop materials she was able to increase her own skills with additional software and the use of emerging technologies. Most important from her perspective was the renewed awareness of the problems of available time for the classroom teacher; the ongoing nature of time as a problem for the practitioner.

Handler gave time, expertise, and support for teachers throughout the project. She was able to provide information on ongoing research, best practices and examples of ways in which other schools and districts were exploring similar technologies. Through her work with administrators, teachers, and instructional assistants she was able to provide professional growth opportunities for many in the district.

In return she received an opportunity to interact in classrooms and labs with students and teachers and to continue an involvement in the area of teacher support that was key to her own research. Working in classrooms in a district with a commitment to professional growth, she could see her own input make a difference for teachers and students. The coordinator had been a graduate of the Computer Education program at the University. Like Unikel, Handler felt great satisfaction in being a part of the support that allowed the coordinator to make strides in accepting a leadership role. Handler also took satisfaction from the growth of Unikel, representing the importance of administrative leaders to model risk taking and growth in a new area.

Cederlund saw the consultant's role as being behind the scenes for the most part. She was there as a support, motivator, and link to others outside the district with expertise. While she saw Handler during the first year as a link to the university, her view during the second year was somewhat different. During the second year Handler was perceived as a person who was a resource to the district. At the end of the second year Cederlund described her view of Handler this way, "Guess what? I can do this on my own, but can I check with you from time to time?" It was time to withdraw the formal link to the university, to the consultant. It was always the intent of this collaboration to make the district independent.

As in any successful partnership one hopes that there will be gains for all parties involved. Such was the case in this collaborative effort. For the teachers as well as for the implementation team it was important to work in "a collaborative, supportive and collegial process of sharing and experimenting in the context of mutual respect and reflection" (Leinwand, 1992, p. 468).

The district has an ongoing plan with involved, enthusiastic and knowledgeable teachers who are now planning technology collaborations among themselves. The technology coordinator, a former classroom teacher and graduate of the university computer education program, developed and used new leadership skills; the assistant superintendent both increased her own technology skills through participating in several of the workshops and had the satisfaction of seeing the growth and change not only in teacher behavior but ultimately in the classroom. The consultant had rich experiences visiting in classrooms and working with students, in watching teachers become excited over the possibilities in the classroom of the technologies they were exploring, and watching her own impact on the curricular changes that were occurring

Starting where the teachers were, involving them in the planning process, and making participation voluntary were all key in making this a successful professional growth experience. Commitment to school improvement, the ongoing positive collegial interactions between members of the implementation team, and a willingness to be flexible, creative, and responsive to teacher needs and concerns characterized the implementation team's focus. With these factors in mind, other districts could move toward the same successful collaborative efforts.

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A Computer Education Model for Inservice Teachers

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With the influx of computers into all levels of schools, inservice teachers must be equipped with computer education to function effectively in their classrooms. However, numerous school teachers are still far from being ready to assimilate computers into their teaching (Lockard, Abrams, & Many, 1990).

This problem is partly because many currently working teachers received their teaching certificates prior to the time when computer education was available to them. Another reason is the failure of existing computer courses that are offered to school teachers. Those failures are often caused by the course's insensitivity to the teacher's learning needs and characteristics. Some teachers feel anxious while learning computer technology simply because they are unable to relate the present learning with any of their past experiences.

The proposed model adopts a developmental view of computer education to school teachers who are novice computer users. This model is designed to prepare inservice teachers with computer competence required for instruction. It involves five stages, with each stage integrating the progress achieved from earlier stages. In other words, new or advanced computer skills are built on previously learned skills to ensure the success of the entire learning process. This paper presents this model and documents how the model has been used to provide computer education to teachers.

The Model

The major content of these five stages include (a) an introduction and demonstration of basic components of a computer system; (b) an explanation and hands-on practice of three types of disk operating systems: commands, graphics, and manuals; (c) the use of computers as a tool: word processing, spreadsheets, graphics, classroom publishing, and telecommunications; (d) the use of computers as a tutor: computer-based instruction and courseware evaluation; and (e) the use of computers as a tutee: structured language of BASIC and hypertext of ToolBook (Lockard, Abrams, & Many, 1990; Taylor, 1980).

In the first stage, the focus is on the rationale of learning and using modern computer technology in schools. The instruction should cover historical development of computer technology, and the impact and contributions the technologies have made in education and instruction. Learning contents of this stage should include the introduction to a microcomputer system. This introduction can be enhanced by demonstrating and explaining the function of basic physical components of a microcomputer, including the central processing unit, memory (RAM and ROM), input and output devices, secondary storage devices, and proper use and care of computer diskettes.

In the second stage, the instructor should expose the teachers to the three major types of computer interface systems: commands, graphics (icons), and manuals. The teachers should be provided with hands-on opportunities to gain mastery on: (a) useful DOS commands: formatting diskettes, opening, saving, copying and deleting files; (b) skill in using a computer mouse: pointing, clicking and dragging while working with computer icons and window systems; and (c) choosing desired software from a menu provided in a networked computer system.

When the teachers move to the third stage, they acquire the concept of using computers as a tool. Learning contents of this stage include concepts and functions of word processing, data management, and telecommunications. The instructor should first guide a discussion on the benefits and concerns of using processing packages, database systems, and telecommunications for instruction. Then the instructor should employ the "learning-by-doing" approach to train the teachers to learn skills of word processing, data entry, retrieval and management, and telecommunications. For mastering these skills, the instructor should design plenty of "hands-on" exercises that are related to teaching or instruction. Examples of these activities include writing a letter to parents by using a computer word processor, keeping students' records by using a spreadsheet or data management system, and communicating with teachers in remote areas by using electronic mail and bulletin boards.

Following the third stage, the emphasis of the instruction is on the introduction and evaluation of computer-based instruction (CBI). The covered content related to CBI should include (a) the definition, nature, and characteristics of CBI; (b) advantages and disadvantages of CBI over instructor-led instruction; (c) the four common types of CBI: tutorial, drill and practice, simulation, and instructional game; (d) important characteristics of quality tutorials, drill and practices, simulations, and instructional games; (e) research findings related to CBI in instruction or learning; and (f) major evaluation criteria including the accuracy of the content, the appropriate design of cosmetic features such as audio, video and graphics, and the ease of use. The teachers should be exposed to both quality and problematic CBI packages, so they can develop their own opinions regarding the selection of quality CBI for instruction. In addition, teachers should be arranged to review and evaluate various CBI packages by incorporating the evaluation criteria.

In the last stage, the focus is placed on the learning of concepts of programming by using structured programming language such as BASIC and dynamic authoring systems such as HyperCard and ToolBook. The model of this article holds the position that the inservice teachers need to acquire concepts regarding how a programming language such as BASIC or Logo works, but they do not need to spend hours trying to master the complex syntax of BASIC or Pascal. This model believes that, in this stage, the focus should be placed on the introduction and facilitation of basic hypertext skills including the creation of textual and graphical objects, and linkage among these objects.

Two factors are heavily emphasized throughout the five stages of this model: the amount of computer operational experiences the teachers have before receiving computer education, and the amount of time they have to practice the learning tasks. It is suggested that the teachers be provided with an ample amount of hands-on opportunities to practice the desired computer skills. Furthermore, the teachers must be able to seek additional assistance from the instructor to remove difficulties in operating any of the computer equipment.

This model also emphasizes the importance of creating a risk-free environment and incorporating effective motivational strategies. A risk-free environment would allow teachers to practice on the identified learning tasks without fear. Effective motivational strategies may include making the learning content interesting and relevant to teachers' experiences and value. For example, the teachers can be asked to identify area in their schools where technology should play an important role. Or, they can be encouraged to develop a workable plan that will integrate computers or CBI into their area of teaching.

The Use of the Model

This model has been tested for its effectiveness in the course, "An Introduction to Computers for Educators," for one semester. The course is a graduate course offered to inservice teachers in the Department of Instructional Systems, College of Education, Pennsylvania State University, Great Valley.

Nine female teachers and one male trainer took the course. Among them, there were five special education teachers, two elementary school teachers, one media specialist. The age ranged from twenty-three to forty-five. One female teacher had more than twenty-five years of teaching experience, and the majority had one to five years of teaching experience. Most had some experience using the Apple series of computers at their schools, but did not have experience in using a Macintosh or IBM microcomputer.

The ten teachers received instruction covered by each stage in the model of this article. The microcomputer used for the course was the Macintosh series of computers. The required textbook was *Microcomputers for Educators* by Lockard, Abrams and. Many (1990). The teachers learned how to operate a computer system, use three types of disk operating systems, and work with a word processor, database and a telecommunication system. They also reviewed and evaluated several CBI packages. Finally, they learned how to use computers as a tutee by using BASIC and HyperCard.

There were two recall tests. The results of the two tests indicated that all of the teachers achieved a mastery learning of the computer terminologies and concepts covered in the course. In addition to the tests, the teachers were required to complete three assignments including (a) a word processing assignment by using MicroSoft Word 5.1a to write a resume and cover page for their own job search; (b) three spreadsheet assignments by using Microsoft Excel 4.0 for keeping student-related records; and (c) a BASIC exercise in the use of three fundamental statements of BASIC: Print, Input, and Let. Although the teachers were not required to do a HyperCard assignment, a hands-on training on the basics of HyperCard was provided. When they were doing these assignments, the instructor was available for help and consultations. All of them completed the assignments successfully.

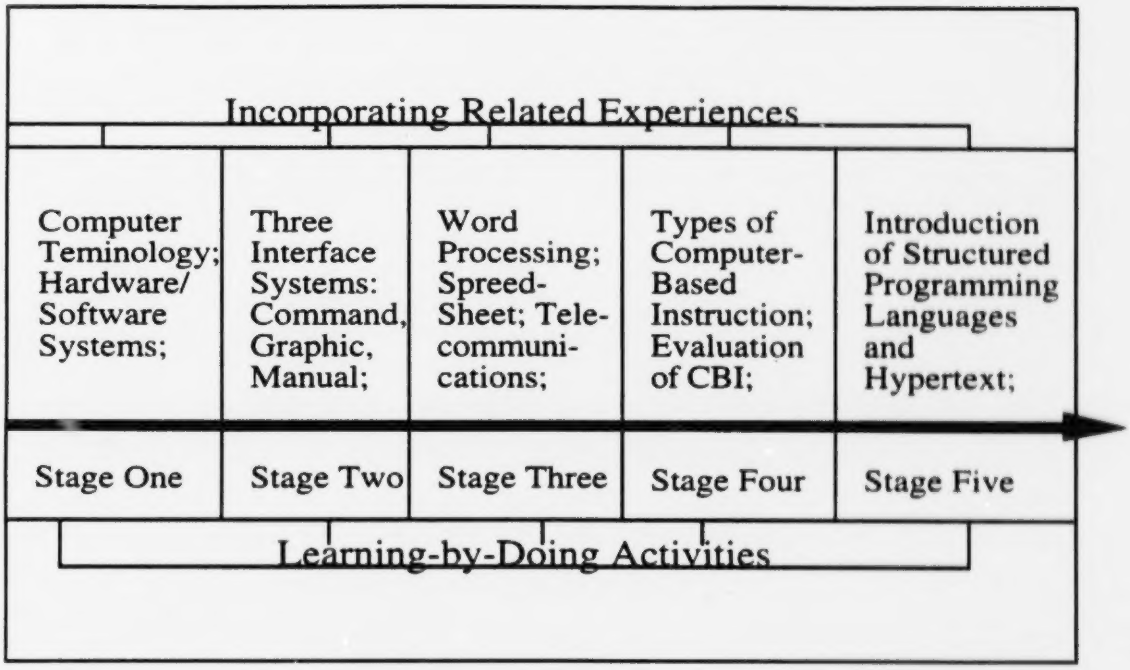
Incorporating Related Experiences
Computer Teminology; Hardware/ Software Systems;
Three Interface Systems: Command, Graphic, Manual;
Word Processing; Spreed-Sheet; Tele-communi-cations;
Types of Computer-Based Instruction; Evaluation of CBI;
Introduction of Structured Programming Languages and Hypertext;
Stage One
Stage Two
Stage Three
Stage Four
Stage Five
Learning-by-Doing Activities

Figure 1: The Model

An attitude questionnaire was administered at the last class. The results indicated that the teachers appreciated the developmental approach used in the model to facilitate their computer competence. They developed a more positive attitude toward learning and integrating the covered computer skills into their professional lives. However, a few of them resisted having BASIC assignments and preferred to have more class time for learning HyperCard and graphic packages.

Summary

This paper presents a model with a developmental view of providing computer education to inservice teachers who are novice computer users. A continuing emphasis of this model is placed on the facilitation of computer competence of school teachers. The model has five stages, with each stage reflects the progress achieved from earlier stages, meaning that the teachers learn new or advanced computer skills only if they have mastered the previously learned skills.

Instructional content covered in the five-stage model includes introduction to computer systems, and disk operating systems, as shown in Figure 1. It also includes the use of computers as a tool, tutor and tutee. The incorporation of related experiences of the teachers and ample amount of hands-on activities is heavily emphasized in the model. This model stresses the importance of having a risk-free environment where teachers can practice the identified learning tasks without fear. Also stressed is the design of the learning content and assignments to be interesting and relevant to teachers' experiences and values.

Finally, this paper documents the process and results of using this model in the course, "An Introduction to Computers for Educators," offered to inservice teachers in the Department of Instructional Systems, College of Education, Pennsylvania State University, Great Valley. There were nine female teachers and one male trainer who took the course. The results of the two recall tests indicated that these teachers achieved a mastery learning of the covered content, and completed the word processing, spreadsheet and BASIC programming assignments. The results of the attitude questionnaire indicated that by taking this course, they had developed a positive attitude toward learning computer technology and hypertext.

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A Model for Training Teachers to Become Independent Hypermedia Designers

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With the rapid advancement of computer technology, teachers are under great pressure to use innovative computer technology to convey instruction. In recent years, hypertext has become a very popular topic in many teacher-training curricula. This is because hypertext is a flexible software technology that can be combined with video, audio and CD-ROM technologies. When used together, these technologies provide a powerful environment for the design and delivery of instruction (Jonassen, 1991).

This paper presents a hypertext training (HT) model for converting school teachers from novice hypertext users to independent hypertext designers. The goal of the HT model is to empower inservice teachers to implement a hypertext package for instructional purposes. The meaning of "independent hypertext designers" refers to teachers who are able to produce, independently and successfully, a hypertext program from procedures of planning, flowcharting, storyboarding, and authoring.

The following sections cover the HT model, contents of the five stages, and how the model was used in a graduate course: "The Design, Development, and Evaluation of Computer-Based Instruction," offered at Pennsylvania State University, Great Valley Graduate Center, to inservice teachers and professional trainers.

The HT Model

The HT model was created based upon The Staged Self-Directed Learning Model (SSDL) of Gerald Grow (1991) for teaching adult learners to be self-directed. Grow believes that self-direction is situational and can be advantageous. As he points out, a learner may be self-directed in one subject or situation, while dependent and hopeless in other subjects or situations. Grow also believes that, "Just as dependence and hopeless can be learned, self-direction can be learned—and it can be taught."

In the SSDL model, there are four sequential stages: dependent, interested, involved, and self-directed. Simply stated, at stage one: *dependent*, learners are dependent. Teachers should help learners remove learning deficiencies and resistance. At stage two: *interested*, learners are inspired to learn. Teachers should use effective motivational strategies to reinforce learners' interests in learning. At stage three: *involved*, learners, as intermediate self-directors, participate in learning, yet need someone to facilitate the learning process. At the last stage: *self-directed*, learners are able to take responsibility for their learning and should be mentored by teachers to reach personal empowerment.

In the context of hypermedia learning, philosophically, the HT model employs the key concept of the SSDL model. That is, teaching teachers to use hypermedia is situational. Teachers with no or limited hypermedia experience would encounter dependency or helplessness in the initial stage of hypermedia learning. However, they can be motivated and guided to reach independence.

The difference between the HT and SSDL model lies in that the HT model is built, specifically, for facilitating computerized hypermedia skills. In comparison, the SSDL model was created to promote general self-directing abilities in learning. The HT model emphasizes instructional planning, understanding the theoretical foundations of hypermedia from both designers' and learners' points of view, and using a hands-on, learning-by-doing approach to acquire hypermedia skills. Moreover, it stresses the importance of having systematic instruction that is responsive and sensitive to the teachers' needs, learning pace, and difficulties.

The HT model adopts the first three stages from the SSDL model: dependent, interested and involved, and adds two additional stages: engaged and independent. In the model, the first three stages are built to motivate the teachers to learn hypermedia, to acquire a theoretical basis of hypermedia, and to evaluate hypermedia packages. The last two stages were created for facilitating hands-on, learning-by-doing hypermedia skills. The instructional sequence and content of each stage in the model are principally based on suggestions by Lockard, Abrams, and Many (1990) for providing computer education to educators; Hannfin and Peck (1988) for the design, development and evaluation of instructional software; Allesi and Trollip (1991) for methods of computer-based instruction (CBI) design; Seyer (1991) for learning hypertext; Myers and Lamb (1990) for learning Apple HyperCard; and manuals for using IBM LinkWay, and Asymetrix ToolBook software.

Stage One:
Teachers as Dependent Hypermedia Novices

Generally, teachers who decide to seek formal classroom instruction or receive training on hypermedia begin their learning with very limited experience in the use of any form of hypermedia. Some of them may have seen demonstrations of hypermedia in their schools and some of them may have played with it, but do not know how to use it. Due to limited knowledge and skills in using hypermedia, they are temporarily dependent learners. As dependent learners, they may have doubts about whether or not they can learn hypermedia. They may even feel anxious about learning it. These types of learners tend to require clear guidelines from the instructor regarding why, how and, when to use hypermedia.

Psychologically, the instructor should help the teachers overcome any feelings of resistance, anxiety, or concerns about using hypermedia. The instructor should emphasize the value of using hypermedia in the design and delivery of instruction in classroom teaching. Demonstrations regarding how effective instruction can be delivered by using hypermedia or multimedia should be included for motivational reasons. Specific learning objectives as well as expectations of the learners upon finishing the course should be provided.

Many popular hypermedia applications such as Apple HyperCard, Asymetrix ToolBook, and IBM LinkWay often require the user to work with a computer mouse. Teachers who do not have much experience in using this type of input device should be provided with hands-on opportunities to gain mastery of certain "mousing skills" including pointing, clicking, and dragging. As for teachers who have very limited computer operational skills, a review of computer terminologies, hardware systems, and DOS commands is very helpful.

In addition, the HT model proposes that novice hypermedia users ought to learn one hypermedia system at a time. Learning several hypermedia systems at one time with limited hypermedia background may hamper the learning results.

Stage Two:
Teachers as Interested Hypermedia Learners

In the second stage, the teachers have been motivated to learn hypermedia, prepared with relevant computer knowledge, and trained to use a computer mouse. They are willing to gain more information about hypermedia. They have passed the stage of asking themselves: "Why hypermedia?" Now they ask another question: "How does hypermedia work?"

The mission of the instructor in this stage is to reinforce the teacher's willingness to learn hypermedia and to provide clear answers regarding how hypermedia functions. Instructional content of this stage should begin with an introduction of hypermedia: its history, characteristics, functions, and usage. The dynamic nature of hypermedia, and how nonlinear, non-sequential hypermedia is different from structured programming languages such as BASIC or PASCAL should also be covered. In addition, the ability of hypermedia to be used in conjunction with other audio and visual media should be emphasized. If possible, the information should be presented by using hypermedia programs or multimedia with attractive graphics, animations, or visual and audio effects.

Furthermore, it is necessary to cover the theoretical foundations of hypermedia. Related topics may include: (a) the historical development of CBI; (b) the nature and utilization of four common CBI modes: drill and practice, tutorial, simulation, and instructional games; (c) advantages and disadvantages of using each of them; and (e) important research findings relating to CBI.

In addition to these topics, theoretical bases of hypermedia, from the perspectives of learners or users, should be introduced. Suggested theories to be covered include information-processing theory, schema theory, and theories of objectivism and constructivism (Jonassen, 1991). Issues raised by hypermedia designers about these theories should be discussed. The instructor should encourage the teachers to express their thoughts concerning these theories.

Stage Three:
Teachers as Involved Hypermedia Evaluators

In the third stage, the teachers who have developed interests and confidence in learning are familiar with the theoretical background of hypermedia from the learner's point of view. Now, they are ready to see what kind of hypermedia is available for instructional purposes. They want to participate in the process that allows them to explore a variety of hypermedia packages, to identify factors related to effective hypermedia, and to determine deficiencies of the existing hypermedia.

The instruction at this stage should be prepared to review and evaluate a wide variety of hypermedia packages. Instructional content should include an introduction of the role of evaluation in CBI and hypermedia learning, and both objectivistic and constructivistic criteria for hypermedia evaluation (Jonassen, 1991). After presenting the teachers with both objectivistic and constructivistic criteria, the instructor should make the teachers compare and contrast these two types of criteria. The instructor also needs to encourage them to consider the appropriateness or feasibility of applying these criteria in hypermedia design and evaluation.

Stage Four:
Teachers as Engaged Hypermedia Authors

In the fourth stage, the teachers have knowledge of hypermedia and have evaluated several hypermedia packages available in the market. Conceptually, they understand the nature and theoretical framework of hypermedia, and how designers have used hypermedia to implement instructional software. In this stage, they are ready to learn the selected hypermedia and create their own projects.

In this stage, the instructor should demonstrate step-by-step how the selected hypermedia operates. Basic functions such as opening and saving files, working with menus and icons, and using palettes and tool boxes should be covered. Next, the instruction should demonstrate how to create objects, information including text, graphics, linkage, and scripts among sets of information. While teaching how to create objects or write scripts, the instructor should cover the basic guidelines for designing and writing them. The covered theories may include guidelines for using different fonts, sizes of text, colors, and icons. The instructor should avoid requiring the teachers to read the hypermedia manual by themselves. Instead, he or she should design an easy-to-read and easy-to-follow set of guidelines for the teachers. The teachers should be allowed to have hands-on practice immediately following the instruction for creating objects, stacks or writing scripts..

Steps for Using ToolBook to Create Graphics:

The following is an example of the step-by-step guidelines for creating graphics in using hypermedia of ToolBook:

1. When you are in ToolBook, you will see a menu on top of the screen, a tool palette on the left side of the screen, and a status box on the left corner of the screen (The status box shows a page icon and two numbers. The first number is the current page number and the second number is the total number of pages).
2. Choose one of the drawing tools (line, angled line, arc, curve, rectangle, round rectangle, ellipse, regular polygon, irregular polygon, or the pie) from the tool palette.
3. A "+" will show on the screen, drag the "+" to draw.

Stage Five:
Teachers as Independent Hypermedia Designers

At this point, the teachers have learned the theoretical foundations of hypermedia, have evaluated hypermedia products, and have mastered the skills of creating objects and linkage in hypermedia. During the fifth stage, they should be provided with an adequate amount of time to independently design, develop, and implement a hypermedia package with a topic that is of interest to them and can be useful for their teaching jobs.

The role of the instructor at this stage is to function as a mentor to foster the teachers' independence, as well as confidence in the implementation of the project. The instructor should encourage the teacher to progress alone, but remain available for help and consultations (Grow, 1991).

The Use of the HT Model

The HT model has been tested for its feasibility and effectiveness in the graduate course, "The Design, Development, and Evaluation of Computer-Based Instruction," offered to inservice teachers and professional trainers at the Department of Instructional Systems, College of Education, Pennsylvania State University, Great Valley. This model has been used for four semesters. Most teachers and trainers registered for the course were able to reach independence in using the selected hypermedia (ToolBook or Quest) program for instructional or training purposes. Most expressed favorable attitudes toward learning and using hypermedia for the design and delivery of instruction or training.

Summary

This paper presents a hypermedia training (HT) model that converts inservice teachers from novice hypermedia users to skilled hypermedia designers. The goal of the HT model is to empower inservice teachers to implement independently a hypermedia package for instruction.

This paper also covers the theoretical framework of the HT model. The model was built by adopting several concepts of The Staged Self-Directed Learning Model (SSDL) of Gerald Grow (1991), which is designed to cultivate the self-directed ability of adult learners. The SSDL model suggests that there is no single best instruction for adult learners due to the diverse background of adults. Teaching adult learners to be self-directed is situational. That is, adult learners can feel helpless in certain learning

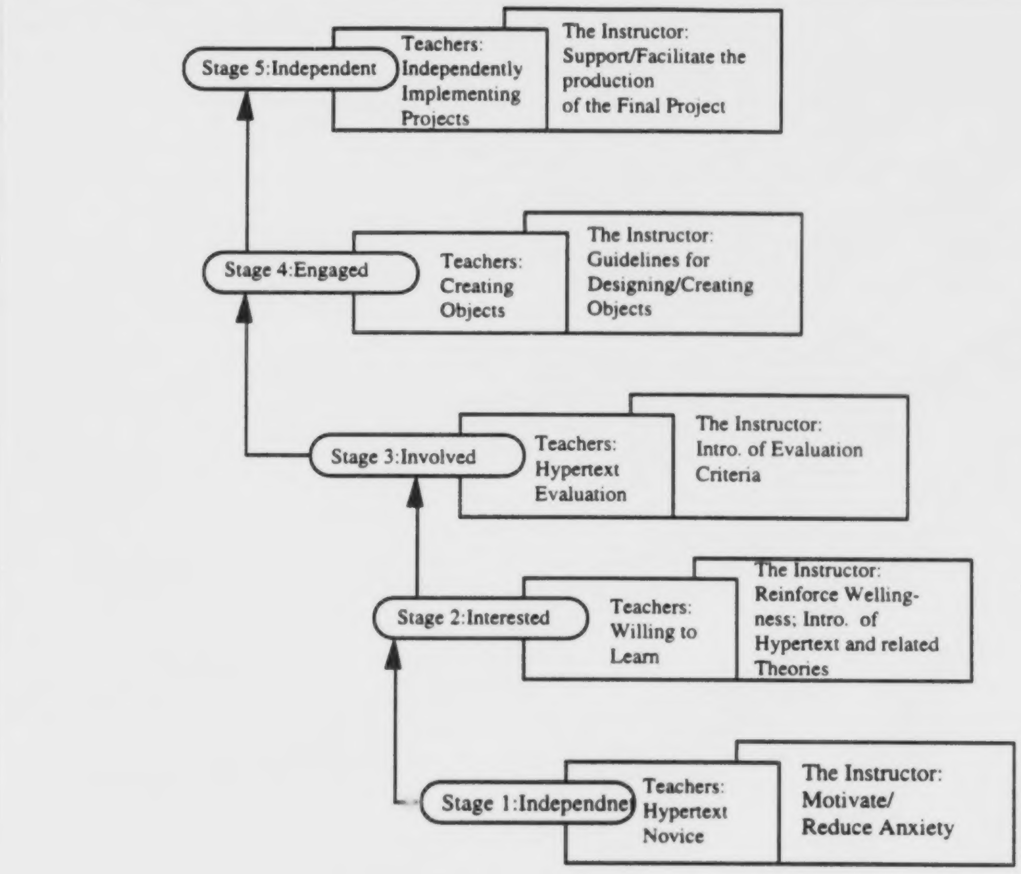
Stage 5:Independent
Teachers: Independently Implementing Projects
The Instructor: Support/Facilitate the production of the Final Project
Stage 4:Engaged
Teachers: Creating Objects
The Instructor: Guidelines for Designing/Creating Objects
Stage 3:Involved
Teachers: Hypertext Evaluation
The Instructor: Intro. of Evaluation Criteria
Stage 2:Interested
Teachers: Willing to Learn
The Instructor: Reinforce Wellingness; Intro. of Hypertext and related Theories
Stage 1:Independne
Teachers: Hypertext Novice
The Instructor: Motivate/ Reduce Anxiety

Figure 1: The HT Model

situations, but confident and independent in others.

In the context of hypermedia learning, the HT model agrees with SSDL model, suggesting that teaching teachers to use hypermedia is situational. Teachers who have very limited computer or hypermedia background experience helplessness or anxiety in the initial learning stage, but they reach independence in using hypermedia. The HT model employs the first three stages from the SSDL model: dependent, interested, involved and adds two additional stages: engaged and independent. The first three stages are designed for motivating the teachers to develop interests and confidence in learning hypermedia, to acquire important theoretical foundations of hypermedia, and to evaluate hypermedia products. The last two stages were built to include a great deal of hands-on exercises to facilitate hypermedia skills of the teachers.

Finally, this paper reports how the HT model was employed to teach teachers and trainers registered in a graduate course: "The Design, Development, and Evaluation of Computer-Based Instruction," offered at Pennsylvania State University, Great Valley Graduate Center.

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SIMULATIONS

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The five papers included in this section describe the expansion of computer-based simulations into several new areas of educational research and application. The two research papers include (1) a pilot study which surveys the accuracy of preservice teachers' feedback to their simulated pupils, and (2) an ongoing study which explores the basic styles that both preservice and experienced teachers employ as they attempt to teach content to simulated pupils. The threeapplication papers include (1) an account of an initial testing of a computer-enhanced simulation designed to facilitate students' understanding of biological change, (2) a description of a project which is designed to teach basic communication skills to professional educators with the aid of a videodisc simulation, and (3) use of a simulation at two different points in the preservice teacher's development of professional skills.

Research papers

At the University of Virginia, the findings from several strands of research on teaching simulations are systematically delineating clear interaction patterns that both preservice and inservice teachers employ as they attempt to work with pupils preprogrammed to present both instructional and classroom behavior challenges. The Strang study describes the validation of a three-dimension teaching-style factor structure with a cohort of experienced teachers, and then discusses each dimension's relatedness to key demographic and lesson-related variables. The prospect for including an additional performance-centered dimension is also discussed. The second study, authored by DeFalco and Strang, investigates the accuracy of teacher-generated feedback. Four participant clusters defined by end-of-lesson text comments are identified, and their relatedness to lesson performance patterns is discussed. The use of the cluster data to identify students in need of individualized instruction is also suggested.

Application papers

In a simulation at Cleveland State University, Ron Abate uses various seeds as prey and various implements as prey collectors in demonstrating natural selection to his students. He is currently testing the utility of employing a Macintosh Powerbook to enhance computation and feedback aspects of this experience.

At the University of Pittsburgh, Janet Olson is developing courseware that is designed to help teachers to acquire fundamental communication skills. Aided by interactive experiences with videodisc simulations, participants, over a short period of time, have realistic exposures to a variety of job-related communication situations. The software package is currently being field tested at several sites in Pennsylvania.

In the final paper in this section University of Houston teacher educator, Dee Anna Willis, and Rebecca Brent of East Carolina University discuss the ways they use a simulation of lesson planning with their students. Brent uses the simulation to introduce students to lesson plan writing while Willis uses it after students have completed methods courses but before student teaching.

Harold R. Strang, an educational psychologist, is a tenured professor in the Department of Educational Studies at the University of Virginia. He teaches an undergraduate course in child development and graduate courses in concepts of learning, human development, and adult development. Over the past decade he and several colleagues have been developing and conducting research on computer-based teaching simulations.

Alice Strang, who holds an M.Ed. in counseling from the University of Virginia, is an employment counselor with a community action agency. She is a former English teacher who has proofread many manuscripts over the years.

Communicating with Computer-simulated Pupils: The Search for Feedback Patterns

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Training preservice teachers to communicate effectively with pupils is an essential goal in any teacher-training program. The feedback that teachers provide to pupils is a linchpin in such communication. Goetz, Alexander, & Ash (1992) describe how teachers can administer feedback in a variety of ways and on a variety of topics ranging from academic performance to pupil deportment.

The content of feedback, regardless of teacher intent, powerfully impacts pupil expectations and subsequent performance. Landfried (1989) describes how teachers often "enable" misbehavior and academic laziness in their pupils either by ignoring or by reinforcing unsatisfactory performance. In the same vein, teachers often ignore or inappropriately punish appropriate behavior.

The Curry Teaching Simulation allows participants to employ many of the feedback elements that teachers typically employ in verbal exchanges with real pupils. Screen menus offer a wide variety of common options ranging from direct praise to information-giving answers, and a recent simulation upgrade even allows participants to issue immediate feedback in the form of complete text statements—statements that can introduce the lesson, prompt erring pupils, and summarize a class's overall lesson performance.

Data generated by over 1,500 simulation participants reveal a wide variety of teacher feedback patterns. While many teachers consistently reinforce appropriate pupil behavior, a sizeable number sometimes reinforce inappropriate pupil behavior. The inappropriate reinforcement phenomenon has been particularly evident over the past several years, a period during which participants have increasingly been exposed to challenging classes—classes in which pupils have been preprogrammed to display low initiative, low academic preparation, and high levels of misbehavior. In offering end-of-lesson comments to these pupils, participants have frequently made broad generalities about how adequate or even exceptional lesson performance has been.

In attempting to better understand the nature of preservice teacher feedback, the present study

1. examines the frequency with which preservice teachers convey accurate and inaccurate feedback in focusing on the accomplishments and deficiencies of their simulated pupils; and then
2. searches for patterns linking the way in which teachers conclude the lesson with the types of feedback that they used in interacting with their pupils during the lesson.

Method

Subjects

Subjects included 135 students enrolled in a five-year teacher-education program at the Curry School of Education. Each subject completed the teaching simulation as part of a laboratory requirement for a learning and development course. Included in the study were 113 females and 22 males who ranged in age from 19 to 41 years. The mean age was 21.6 years with a standard deviation of 3.4.

Simulation Experience

Each subject, assigned the role of a teacher, was introduced to one of two parallel teaching simulations while seated at a MS-DOS computer. Activity focused on reviewing a spelling and math assignment with 12 simulated pupils. These pupils were preprogrammed to vary in initiative, level of preparedness and propensity to misbehave. The teacher interacted with pupils via two forms of keyboard input. The first reflected menu options; the second, text statements. After 50 interactions had been completed, the teacher had the opportunity to create a closing comment to the class. The session concluded with the completion of several short post-lesson questionnaires followed by a debriefing.

Text Coding

The contents of teacher closing comments were coded according to both the type of performance feedback (performance focus) and the accuracy provided (performance accuracy). Of the 92 teachers who provided closing comments, 74 females and 11 males submitted pupil performance information that could be coded. The current study centers on this group's end-of-lesson feedback as defined by the following two categories.

Performance Focus. This dichotomous coding category addresses the focus of the teacher comments and questions whether the comment emphasizes (1) class/pupil accomplishments or (2) class/pupil deficiencies.

Performance Accuracy. This dichotomous coding category addresses the accuracy of the teacher comments and questions whether the comment feedback was (1) accurate in describing class/pupil performance or (2) inaccurate in describing class/pupil performance.

As a result of the coding, each subject was assigned to one of the following four feedback cells.

Accomplishments: Accurate feedback. This cell included text statements which accurately addressed lesson-related accomplishments. Teachers assigned to this category (1) provided accurate information to the entire class about its accomplishments (e.g., "Everyone did a good job in taking out their books when I asked") or (2) provided accurate information to a group of pupils about their accomplishments (e.g., "I am very pleased with those of you who remembered the classroom rules").

Accomplishments: Inaccurate feedback. This cell included text statements which inaccurately addressed lesson-related accomplishments. Teachers assigned to this category provided inaccurate information to the entire class about its accomplishments (e.g., "Everyone did a great job today") or (2) provided inaccurate information to a group of pupils about their accomplishments (e.g., "Most of you were prepared for today's lesson").

Deficiencies: Accurate feedback. This cell included text statements which accurately addressed lesson-related deficiencies. Teachers assigned to this category (1) provided accurate information to the entire class about a deficiency (e.g., "Class, next time you all need to remember to quiet down when I first come into the room") or (2) provided accurate information to a group of pupils about its deficiencies (e.g., "Most of you need to remember the rules of the classroom").

Deficiencies: Inaccurate feedback. This cell included text statements which inaccurately addressed lesson-related deficiencies. Teachers assigned to this category (1) provided inaccurate information to the entire class about its deficiencies (e.g., "Class, none of you listened today") or (2) provided conflicting and confusing information about pupil and/or class performance (i.e., "Everyone did a great job today, but you all need to pay attention to classroom rules").

Analyses

After the matrix defined by performance focus and by performance accuracy had been developed, the relationships between these two independent variables and several clusters of dependent variables which defined simulation performance were assessed via a series of two-way analyses of variance. The dependent variable clusters included: (1) factor scores for three teaching style dimensions that had been isolated by Strang and Moore (in press), (2) scores for two lesson-related variables that define a teacher's display of positive and negative affect, and (3) scores for two lesson-related variables that pertain to content mastery. The results of these analyses must be viewed with caution due to the potential for Type I errors linked to the variable selection procedures.

Results

Feedback frequencies for closing comments

Table 1 presents cell frequencies representing performance accuracy and focus codes derived from the teachers' closing comments.

Table 1
Coding matrix

	Accurate	Inaccurate
Accomplishments	10	40
Deficiencies	24	11

Lesson performance patterns

The independent variables, performance focus and performance accuracy, were then included in a series of 2-way analyses of variance (ANOVAS) to assess their relatedness to the variables in each of the clusters. The first dependent variable cluster consisted of the factor scores for the three teaching style dimensions. One significant Factor 1 main effect was found. Teachers whose closing comments focused on pupil accomplishments rather than on pupil deficiencies were more likely to use behavior management techniques throughout the lesson ($p<.01$).

The second dependent variable cluster consisted of two measures of a teacher's use of affect during the lesson: the teacher's expression of displeasure and the teacher's use of praise. Two significant main effects were found. Teachers whose closing comments focused on the accomplishments rather than the deficiencies were more likely to use praise (p<.01) and were less likely to express displeasure with pupil performance (p<.03).

The third dependent variable cluster consisted of two markers of content mastery: the number of correct pupil answers to teacher-posed content questions and the number of interactions that the teacher devoted to lesson content. Two interaction effects were found. Post hoc tests of individual cell differences revealed that:

1. teachers whose closing comments inaccurately assessed pupil accomplishments promoted significantly more correct responding in their pupils than did the teachers in any of the other three groups; and
2. teachers whose closing comments inaccurately assessed pupil deficiencies initiated significantly fewer content-related interactions than did the teachers in any of the other three groups.

Discussion

Within the context of simulated teaching, the results of this study provide several interesting insights into the feedback patterns of preservice teachers by:

1. identifying a large number of preservice teachers who provide their pupils with inaccurate feedback;
2. demonstrating the relationships between teacher closing comments and the ongoing communication patterns that teachers maintain with their pupils throughout the lesson; and
3. isolating a group of teachers who may require individualized guidance in developing several fundamental communication skills necessary for effective teaching.

Inaccurate information in closing comments

An inspection of the cell frequencies presented in Table 1 reveals that 60% of the preservice participants provided pupils with inaccurate information regarding their performance during the lesson: Forty-seven percent provided inaccurate assessments of pupil accomplishments, while 13% provided inaccurate assessments of pupil deficiencies. It is quite possible that those teachers who offered inappropriate praise identified with the power of positive reinforcement, yet they failed to realize that reinforcement, when linked to inappropriate behavior, yields undesirable learning outcomes.

Lesson performance comparisons

The type of feedback that teachers used in their closing comments related to the communication patterns that they had employed during the lesson. Three specific effects were isolated.

Teaching styles. Teachers whose closing comments focused on pupil accomplishments rather than on pupil deficiencies tended to use more effective behavior-management techniques throughout the lesson. By quickly quelling misbehavior outbursts, these teachers could devote more time to their teaching goals.

Affect. Closing comment type also related to the way in which teachers communicated affect to their pupils during the lesson. The affective direction, positive or negative, that teachers displayed in their closing comments, tended to match that which they had displayed in their lesson interactions. For example, teachers who focused on accomplishments in their closing comments were more likely than those who focused on deficiencies to praise their pupils and were less likely to express displeasure at pupil misbehaviors elsewhere in the lesson.

Content mastery. Analysis of the variables in the third cluster provided two interesting results. The first analysis revealed that teachers who inaccurately assessed pupil accomplishments promoted significantly more correct responding in their pupils than did teachers in any of the other three groups. This finding, however, must be viewed within the context of overall pupil performance—a context in which only 14.8% of class time was free of misbehavior and where teacher-solicited homework answers yielded an accuracy rate of only 56.8%.

The second analysis revealed that teachers whose closing comments inaccurately assessed pupil deficiencies initiated significantly fewer content-related interactions than did the teachers in any of the other three groups. This result, coupled with several other findings, helps to define a teaching pattern which is discussed in the next section.

A group that needs help

An overall view of the cell means for the dependent variable clusters reveals an interesting yet disturbing pattern. During the simulation, the eleven teachers whose closing comments focused on inaccurate assessments of pupil deficiencies, when compared with other teachers, tended to display an array of ineffective classroom behaviors. This array included more effort directed toward misbehavior intervention, less effort directed toward lesson content, and a higher probability of eliciting content errors from pupils. Because these teachers were unable to deal with the recurring waves of pupil misbehavior, they had little time to attend to the lesson or to the individual needs of their pupils. Before they assume the responsibilities of a "live" class, the preservice teachers who display this pattern may particularly profit from individualized instruction in fundamental classroom skills. The simulation's evolution as an accurate approximation of real classroom experiences will undoubtedly be matched by its increasing utility as a diagnostic tool.

Acknowledgements

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Assessing Teaching Styles in Experienced Teachers via a Microcomputer Simulation

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Over the past two years, a major strand of the Curry Teaching Simulation's research has addressed the variations in the techniques that preservice teachers use as they attempt (1) to help software-defined pupils to learn content and (2) to maintain pupil discipline in classes that invariably have been "preset" to present both instructional and misbehavior challenges. The results of a study conducted by Strang and Moore (in press) yielded distinct behavior clusters which define three aspects of how teachers navigate lessons. As presently interpreted, these technique dimensions describe how individual teachers:

- respond to misbehavior (use traditional techniques versus use nontraditional techniques);
- teach lesson content (embrace student individuality versus fail to embrace student individuality); and
- sequence activities (function deliberately versus function spontaneously).

By focusing on a diverse sample of 57 experienced teachers, the current study seeks both to validate and to expand our knowledge of the three teaching style dimensions. Specific goals include:

1. an attempt to replicate the factor structure obtained with previous preservice student samples;
2. a comparison of the experienced teachers' style scores with those of a preservice sample to ascertain whether profile differences exist between the two levels of experience; and
3. a comparison of the experienced teachers' style scores with (a) prominent demographic variables (gender, teaching longevity, and teaching specialty), and (b) selected simulation performance variables to better interpret the characteristics of the three style factors.

The ultimate goal of this research strand is to delineate the paths that experienced teachers follow in effective instruction and behavior management—paths which then can be used as templates in the training of preservice teachers.

Method

Subjects

Subjects in this study were selected from two pools. An experienced group contained 57 Virginia public school teachers drawn from off-grounds graduate-level courses offered by the Curry School of Education. A preservice group (described by Strang and Moore, in press) contained 135 teachers-in-training drawn from an on-grounds human learning and development course completed by students in their second year of professional training. The proportions of female subjects in the experienced group and in the preservice group were 91% and 84% respectively.

Procedure

All subjects individually completed a Teaching Worlds computer simulation during which they reviewed spelling\math assignments with a class of 12 software-defined pupils (Strang, 1993). The class was preprogrammed to offer three distinct teacher challenges.

- Eight pupils would show no initiative to participate in lesson-related activities;
- eight pupils had not prepared their homework assignments; and
- ten misbehavior outbursts (each consisting of an instance of pupil daydreaming and an instance of unauthorized pupil talking out) would occur over the course of the lesson.

During the 50 interactive exchanges (events) which defined each lesson, subjects communicated to individual pupils or to the entire class via two forms of keyboard input: (a) single keystrokes which designated choices offered by screen menus, and (b) typed-text entries which were available during lesson introduction, remedial prompting, and lesson closing. After finishing a lesson, subjects submitted initiative, academic improvement, and self-control ratings for each pupil via a computer-administered questionnaire. Participation concluded after subjects completed several short paper-and-pencil questionnaires and received a debriefing from a system operator.

Results

Factor replication

Before considering mean differences between experienced and inexperienced teachers, it was important to determine whether data from the two groups were structurally similar. To this end, the experienced teachers' data were subjected to an analysis identical to that which had been applied to the preservice teachers' data (Strang and Moore, in press). First, a correlation matrix was generated and three principal components were extracted. Next, the three components were rotated to simple structure according to the varimax criterion. Finally, loadings for the three rotated factors from the inexperienced teachers were compared pairwise with those obtained from their experienced counterparts (Gorsuch, 1974, pp. 253-254). As can be seen in Table 1, there were moderately high similarities between corresponding factors (coefficients ranging from .84 to .85), and low similarities among non-corresponding factors. Thus, the style patterns identified by Strang and Moore (in press) are clearly replicated for the group of experienced teachers.

Table 1
Coefficients of Congruence Matrix

	Factor 1	Factor 2	Factor 3
Factor 1	+.84	+.24	-.20
Factor 2	-.16	+.85	+.34
Factor 3	+.15	-.08	+.84

Group differences

The next series of analyses addressed group differences on the three style factors. The dependent variables, factor scores for the three measures, were obtained from a principal components factor analysis with a varimax rotation applied to the 15 simulation performance scores of the combined experienced and preservice samples. The results of independent t-tests performed on the three factor score variables revealed

- that no significant group differences existed for the misbehavior intervention variable, $t(190)=.80$, $p>.1$;
- that experienced teachers focused more on pupil individuality than did preservice teachers, $t(190)=3.16$, $p<.01$; and
- that experienced teachers were more deliberate in conducting the lesson than were preservice teachers, $t(190)=6.35$, $p<.01$.

Table 2 displays group means and standard deviations for the three factor score variables. Note that individual values are expressed as standard scores with a mean of 100 and a standard deviation of 15.

Table 2
Factor Score Means and Standard Deviations

	Preservice (n=135)		**Experienced** (n = 57)	
	M	SD	M	SD
Factor 1 scores	99.44	14.21	101.33	16.79
Factor 2 scores	97.83	13.84	105.14	16.45
Factor 3 scores	95.93	12.07	109.63	16.88

Experienced teachers differed significantly from their preservice counterparts on 7 of the 15 simulation performance variables that had been used to build the three factors. Table 2 presents a summary of significant group differences that resulted from t-tests applied to these variables.

Table 3
Group Differences on Individual Simulation Performance Variables

Factor	**Variable/Effect**
1	Experienced teachers were less apt to use the ineffective technique of engaging misbehaving pupils in off-task conversation (p<.01).
2	Experienced teachers were more apt to ask pupils to "take a moment and think about how to answer" a particular question (p<.01).
2	Experienced teachers were more apt to ask the class to indicate who was prepared to answer a particular content-based question (p<.03).
2	Experienced teachers were less apt to solicit answers from pupils who were not prepared to answer correctly (p<.05).
3	Experienced teachers spent more time completing each lesson-related event (p<.01).

3 Experienced teachers were apt to wait longer before attempting to intervene a misbehavior (p<.01).

3 Experienced teachers were less apt to interrupt class activity to intervene a non-disruptive daydreaming misbehavior (p<.01).

Factor-demographic variable relationships

Relationships between experienced teachers' factor scores and three demographic variables were explored via multiple regression procedures. The demographic variables, obtained from post-lesson questionnaire responses, included gender, teaching longevity, and teaching specialty.

Gender. Experienced subjects included 52 females and 5 males.

Teaching longevity. Subjects' classroom experience ranged from first year of teaching to 26 years of teaching, with a mean of 9.19 years (SD=6.32).

Teaching specialty. Each subject was assigned to one of six teaching specialty categories. Total counts revealed that 23 subjects primarily taught academic content to elementary students; 13 primarily taught academic content to middle-school students; 8 primarily taught academic content to secondary students; 5 primarily taught academic content to students with special needs; and 5 primarily taught academic content students enrolled in gifted programs. A final "low-representation" category included two music teachers and a physical education teacher.

Stepwise multiple regression procedures were employed to assess whether individual demographic variables were related to each of the three factors. In all analyses, the six teaching specialty categories were treated as dummy variables.

Misbehavior management. One significant effect emerged: the middle-school teaching variable explained 11.0% of Factor 1's variance (p<.02). Middle-school teachers exhibited fewer traditional behavior- management responses than did teachers in other specialty categories.

Instructional delivery. One significant effect emerged: the special education teaching variable explained 11.1% of Factor 2's variance (p<.02). In delivering content, special education teachers exhibited more student-sensitive responses than did teachers in other specialty categories.

Activity sequencing. One significant effect emerged: the teaching experience variable explained 19.3% of Factor 3's variance (p<.01). Teachers with more experience interacted with their students more deliberately than did teachers in other specialty categories.

Summary/Discussion

The validity of the three teaching style factors was established by the strength of the replication across the two groups. Based on the professional histories of the subjects in the samples, this powerful replication effect affirms that the fundamental behavioral patterns defined by each of the style factors were shared both by inexperienced and experienced teachers.

The second series of analyses addressed whether the direction of the behavioral patterns which define each style differed across the two groups. Clear experience effects were found for Factors 2 and 3. Experienced teachers focused more on student needs and were more deliberate in teaching their lessons than were their inexperienced counterparts. In short, they were more likely to exhibit what Jacob Kounin (1970) called "withitness."

The results of the follow-up t-tests further delineated the specific teacher behaviors which contributed most powerfully to the group differences across the style factors.

Factor 1 behaviors. As previously cited, the two groups did not differ significantly on the factor score dependent variable for misbehavior intervention and showed differences on only one of that factor's five teacher behaviors, the probability of engaging in off-task conversations with misbehaving pupils. A comparison of the current results with those obtained in an earlier study that contrasted the simulation performance of experienced teachers with that of non-teachers (Strang, Vekiari, & Tankersley, 1991) provides one interesting finding. Examination of a shared key variable, the likelihood that a teacher would successfully quell a misbehavior via an initial intervention attempt, revealed that the experienced teachers in both studies demonstrated high session 1 proficiencies, 83% and 79%, respectively. The preservice teachers in the current study also performed in the same range (80%), while the subjects in the earlier study, individuals who had no professional aspirations to become teachers, exhibited notably inferior performance (65%).

Factor 2 behaviors. The experienced teachers' greater sensitivity to pupil needs during instruction was most clearly defined by three distinct actions: their alerting pupils to "think before answering," their linking pupil participation to pupil initiative, and their decision not to solicit content-based answers from unprepared pupils. The current study replicated the effect for think-time, the one dependent Factor 2 variable shared with the study reported by Strang, Vekiari, & Tankersley (1991).

Factor 3 behaviors. The experienced teachers' greater deliberation in sequencing activities was shown by their spending more time to complete lesson events, by their waiting longer before attempting to intervene misbehaviors, and by their refraining from interrupting lesson activity to deal with non-disruptive daydreaming misbehavior. While not addressing identical variables, results related to a teacher's interrupting the lesson to deal with misbehavior clearly paralleled those reported by Strang, Vekiari, & Tankersley (1991).

The third series of analyses, which focused on the relatedness of prominent demographic variables to the individual factors, yielded three modest effects.

Middle-school effect. Middle-school teachers exhibited fewer traditional behavior-management responses than did other teachers. This finding offers a provocative parallel to the work of teacher educators, Descamps and Lindahl (1988), who state that middle-school teachers should pursue eclectic approaches to classroom management. Their

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recommendation is based on a conclusion that "more than any other school level, the middle school population tends to exhibit great variety in terms of stages of physical, intellectual, social, and moral development" (p. 8).

Special education effect. Special education teachers were more sensitive to pupil needs than were other teachers. This effect, while not demonstrated by preservice teachers (Strang & Moore, in press), may well have reflected this group's expression of fundamental special education doctrine—doctrine summarized in the following statement. "Among the foremost principles upon which the field of special education was initially founded is the importance of individualization in instructional programming" (Polloway, Cronin, & Patton, 1986, p. 22).

Experience effect. Teachers with more experience exhibited greater deliberation in interacting with their pupils than did other teachers. In light of the age effect identified in the preservice group by Strang and Moore (in press), the current study's experience effect may largely reflect the major contributions of maturational influences—influences that may center either on the currently proposed heightened thoughtfulness or on less constructive features such as heightened cautiousness. Directing future research toward (1) the refinement of the factor structure and (2) the study of variables that define teacher motives as well as teacher behaviors will hopefully lead to a better understanding of the dimensions of this as well as the other two factors.

Factor refinement

After the validity of the factors had been affirmed and their relationships with demographic measures had been explored, an attempt was made to isolate additional simulation performance variables that would strengthen the existing factor structure. To accomplish this, correlations between factor scores and selected performance variables were computed. Variables were found to correlate significantly with each of the three factors. Factor 1 scores were negatively correlated with the number of different ineffective misbehavior intervention techniques that the teacher used (r=-.69), were negatively correlated with the likelihood that the teacher would discontinue intervention before quelling a misbehavior (r=-.64), and were positively correlated with the probability that the teacher would use an unobtrusive misbehavior management technique such as establishing eye contact or physically approaching a misbehaving pupil (r=.38). Factor 2 scores were negatively correlated with how often the teacher shifted attention from one pupil to another (r=-.53); with the probability that an unprepared pupil who participated in lesson activity would commit an error (r=-.65); and with the probability that once having committed an error, an unprepared pupil would be asked to answer another item without first receiving help (r=-.50). Factor 2 scores were also positively correlated with the probability that the teacher, after intervening a misbehavior, would return to the current content item (r=.53). Finally, two significant but small Factor 3 correlations were found. This dimension's factor scores were positively correlated with how much time the teacher spent introducing the class to the upcoming lesson via a text comment (r=.24) and with how often the teacher initiated status checks to determine the portion of the lesson that had been completed (r=.21).

The eight new variables described above, along with several others drawn from both lesson performance and end-of-session ratings, have been added to the existing factor variable pool. The results of preliminary analyses, in addition to reproducing the three current factors, suggest the existence of an additional factor. Centering on variables which address correct pupil answering, this factor appears to reflect the degree to which a teacher emphasizes pupil achievement during the lesson. Further exploration of the teaching simulation factor structure will continue with a new subject cohort comprised of preservice teachers enrolled in the Curry School's learning and development course during the current semester.

Acknowledgments

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Modeling Concept Development Techniques via a Simulation of Natural Selection

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A computer-augmented simulation of natural selection, used in a graduate-level course on instructional development, was tested over two academic quarters to determine whether the simulation worked as designed and whether the simulation improved student understanding of the concept of natural selection. Continual revision of the prototype led to software that was reliable and reasonably user friendly. An exploratory study examined the effects of use of the software on changes in students' understanding of natural selection. This exploratory study raised several questions for future consideration.

Predator and Prey Simulation

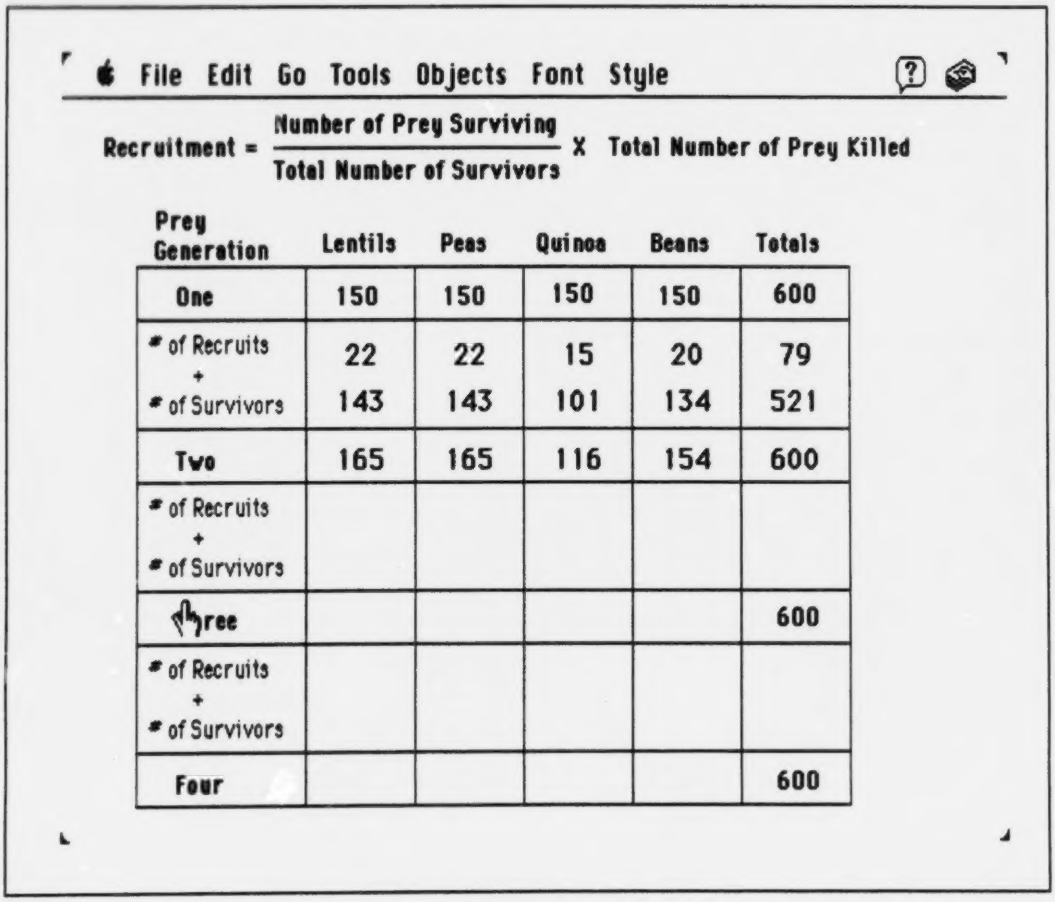
Charles Darwin's contribution to evolutionary theory is commonly referred to as "survival of the fittest." This popular phrase has a variety of interpretations, not all of which are accurate. One frequently encountered interpretation centers on "tooth and claw" combat. This interpretation is promoted in a fast-paced television commercial where different animals literally fight for their lives. In the commercial, natural selection appears to hinge on the physical strength of the combatants. In reality, the competitive mechanisms of nature are more subtle, paced and powerful than this commercial leads an audience to surmise. Natural selection is driven by the long-term effects of variation within and between species. Successful variations accumulate over time, while less effective variations become extinct. Despite the importance of species variation, many students overlook its contribution in explanations of biological change (Abate, 1993).

Given an environment, a predator population, and a prey population, is it possible for students to generalize the importance of variation in natural selection? To answer this question, I revised an experiment from an undergraduate environmental studies class (Bodkin, 1987). In this paper-and-pencil exercise, students simulate predator and prey relationships based on a simple model of species variation. Students are first assigned to a predator population. Prey, in the form of a variety of seeds, are scattered on a lawn, and the student predators then collect the prey with predator-specific tools. The paper-and-pencil version of this simulation requires students to compute future generations of predators and prey by hand, double check the figures and verify that the results follow the population formula correctly. The data collection portion of the experiment can be compromised by simple computation errors that invariably distort the composition of future predator and prey generations. In addition, the need to compute data by hand increases the amount of time required to run the simulation. Despite these drawbacks, the paper-and-pencil activity offers a workable simulation of natural selection.

Computer-augmented Simulation

The computer-augmented predator and prey simulation began with a pre-test on students' understanding of biological change followed by a class discussion of the assumptions underlying a natural selection model (Botkin, 1987). It was hypothesized that knowledge of these underlying assumptions and the experience of collecting data would contribute to the students' understanding of the concept of natural selection.

A HyperCard stack was developed to automate the computation process (see Figure 1). This stack accepts information on how many prey have been collected, returns information on survivors, and recruits for the next generation of predators and prey. Current implementation of the stack includes storing the predator and prey data on the hard drive of a Macintosh Powerbook. The battery power, light weight, and small size of the Powerbook allow the simulation to be implemented in the same outdoor environment in which the paper-and-pencil version had been run. An additional benefit of the computer version became evident at the conclusion of data collection. Data from the HyperCard stack can be transferred to an integrated package for automated graphing of results. These graphs may then be displayed in class on an LCD screen, transferred to transparencies or printed out for the student analysis (see Figures 2 & 3). The computer automation of data collection reduced the data collection time by more than fifty percent which, in turn, created additional time for student data analysis.



$$\text{Recruitment} = \frac{\text{Number of Prey Surviving}}{\text{Total Number of Survivors}} \times \text{Total Number of Prey Killed}$$

Prey Generation	Lentils	Peas	Quinoa	Beans	Totals
One	150	150	150	150	600
# of Recruits + # of Survivors	22 143	22 143	15 101	20 134	79 521
Two	165	165	116	154	600
# of Recruits + # of Survivors					
Three					600
# of Recruits + # of Survivors					
Four					600

Figure 1
Sample Screen from HyperCard Stack

The HyperCard version of the predator and prey simulation worked as follows. The students were told that they would assume the role of predators in an experiment on the processes of natural selection. Student predators varied according to the type of tool that they would use to collect their prey. The five variations of collecting tools included chopsticks, sticky tape, knives, forks, and spoons. One member of each predator group was assigned the role of leader. The leader was given a bowl to store the captured prey and a form on which to record the type and quantity of prey captured during each session (generation) of the experiment.

The prey species consisted of four types of seed that varied in size, shape and weight. There were 150 of each type at the start of the experiment. The quinoa prey were

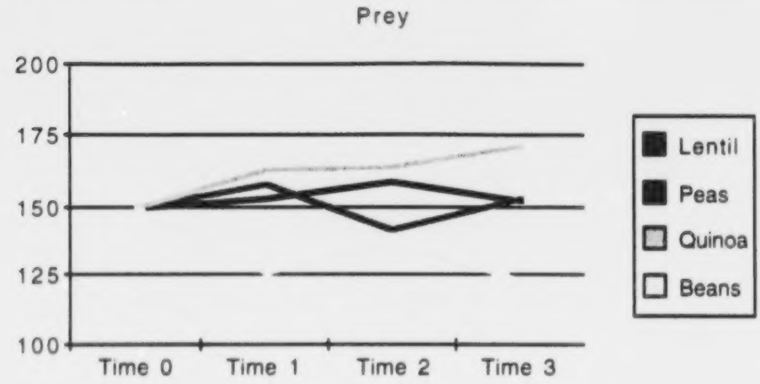


Figure 2
Changes in Prey Population

off-white, very light in weight and somewhat larger than the head of a pin. In contrast, the black beans were the heaviest, largest and darkest prey. The split green peas and lentils were similar in weight and size, falling somewhere between the quinoa and the black beans. The brown lentils blended with the soil of the lawn area while the green peas blended with the blades of grass. The students examined the prey and collecting tools and made some predictions concerning which prey and which predators would be successful. The students then proceeded to the predefined ecological niche (a lawn area on campus) where six hundred prey had been randomly scattered.

Before completing the exercise, each predator group was organized into four-member teams. Teams were informed that they were to collect as many prey as they could during a simulated generation. After thirty seconds of prey collection, the generation ended, predators were regrouped, prey were tallied, and totals were entered into the computer.

The number of individuals that can be maintained in an ecological niche is limited by the resources available to that niche. This resource-based "carrying capacity" serves an important role in determining population growth and species survivability. The carrying capacity was set to 600 for prey and 20 for predators in each of the three simulated generations. Recruitment was based on a formula which took into account the number of a particular prey or predator type surviving, the total number of survivors, and the total number of prey or predators surviving. The program calculated the composition of the next generation based on the population change formulas. Recruits for the prey variations were counted and added to those already on the lawn. Predators were required to capture a set number of prey if they were to reproduce a succeeding generation. For example, in our experiment, since the chopstick variation was not successful at capturing prey, it became extinct after only one generation. The carrying capacity for predators did not change between generations. The students who had been members of the chopstick predator group were assigned, for subsequent generations, to one of the surviving predator groups, e.g., the spoons.

Concept Development

What traits improve a species' chance of survival? Is it possible to explain why a trait reduces the chances of survival? What can be generalized about biological change? What do the data suggest about changes across the generations? These were just a few of the questions posed to the students. The experimental data were graphed to help the students to visualize the population changes (see Figures 2 & 3). The discussion portion of the activity focused on the collected data. The students compared, explained, generalized and made predictions using the collected and graphed data as well as a matrix that they had developed on species traits prior to data collection. These instructional strategies, combined with teacher questioning, were employed to improve concept development (Eggen, Kauchak, & Harder, 1979). Copies of the graphs on changes for both the predators and prey were distributed at the start of the next class. We began our discussion with the predator populations. The students explained the graphs on the basis of their personal experiences as predators.

One pre-experiment prediction included the extinction

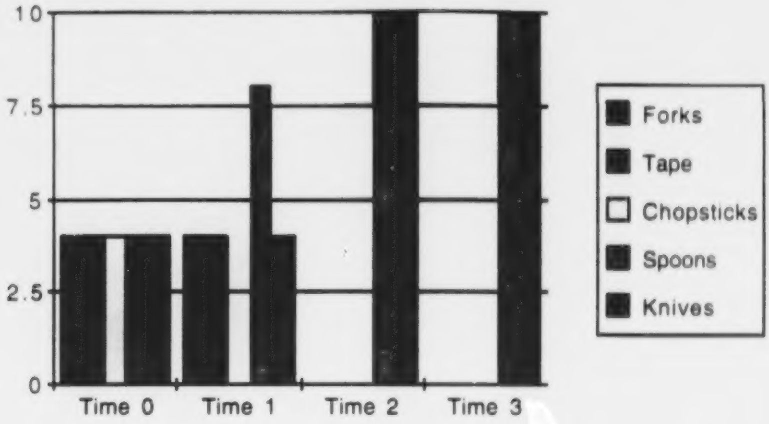


Figure 3
Changes in Predator Population

of the chopsticks predators. Students based this prediction on their familiarity with and difficulty with using chopsticks. This prediction was substantiated by the experiment. A second pre-experiment prediction, however, did not hold. Students imagined that the sticky surface of the tape would prove to be a successful adaptation for collecting prey. What the students realized after one generation was that the tape also picked up grass clippings, dirt, and stones, thus decreasing available surface area. In addition, dew from the grass saturated the tape and reduced the adhesive strength of the glue.

"What if" questions were posed on each predator variation—e.g., "What would have happened if all the predators were tape or chopsticks?" or "What if the niche was a flat surface like the floor?" Additional questions and the subsequent discussion led the class to the conclusion that variation is a key element of survivability.

The results of the experiment on the prey population were less definitive than those on the predator population, but several trends did appear in the data. The quinoa population increased, the black bean population decreased, and the lentil/split pea population oscillated around 150 individuals. The students used the prey graph to support the key generalization that the prey who survive generate offspring and that the offspring, in turn, increase the incidence of the desired trait in the population. After the students had shared their insights on beneficial and harmful traits, we talked about other factors that might have influenced the results. Predictions were offered on the success of one prey over another, and the students generalized the results of the experiment to different environments, different predators, and different prey.

Preliminary Results and Discussion

One group of students was pre- and post-tested using two versions of a test which assessed understanding biological change (Settlage, 1993). Each of the test's twelve questions consisted of two parts. The first part involved choosing the phrase that predicted the outcome of a situation describing some aspect of biological change. The second part required selecting the reason for the choice made in the first part. An answer was considered correct only if both selections were accurate. Of the 24 students who participated in the experiment, 17 showed improvement from the pre-test to the post-test. Four of the top five pre-test scores were among the group of students who did not show improvement. Were the two sets of scores significantly different? A t test for related samples, applied to the two sets of scores, revealed that the across-test improvement was significant ($p<.001$). Since the informal study did not include a control group, it was impossible to determine whether this improvement resulted from the increase in time available for class discussion or whether the simulation itself provided the students with additional insights into the mechanisms of natural selection. At best, the evidence collected in this informal study attributed an instructional benefit to a combined simulation/discussion approach.

One question that surfaced from the informal study was whether students who experience the computer-augmented simulation gain a greater level of understanding of natural selection than do students who experience more traditional instruction on this topic. How this computer-augmented simulation will compare to the paper-and-pencil version of the simulation or to more traditional instruction is clearly open to question.

The novelty of the computer simulation, along with the availability of additional time for discussion, encouraged these students to analyze the collected data more fully. The depth of class discussion, predictions made, and explanations provided surpassed those encountered in previous implementations of the paper-and-pencil simulation. Lacking a formal analysis, personal experience with the computer version of the simulation and the anecdotal comments offered by the students suggest that the effects of the simulation are positive and that a formal investigation might prove promising. Future investigations will examine how the computer augmented simulation contributes to students' understanding of biological change.

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Development of a Videodisc Simulation to Teach Communication Skills

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The issue of professionalism and the way the professional interfaces with the community is a growing concern to the field of education as we approach the 21st Century. The ability to communicate effectively is an ever present priority if we in education are to move toward a restructured system that promotes positive professional relations and cooperation with the parents and the community. During the past decade, the expanding literature on home-school partnerships has identified the need for both teachers and parents to share responsibility in educating today's students (Swap, 1993). In order to support such a partnership, it is imperative that both teachers and parents communicate clearly and effectively.

Microcomputer technology has emerged as a viable means by which preservice or inservice teachers can learn new skills or upgrade their competencies. Simulations provide the opportunity for teachers to gain experience with new and unusual circumstances in an environment that is both realistic and nonthreatening. An added benefit of simulations is that teachers can gain knowledge and expertise through interaction with composite scenarios that would be difficult or impossible to provide consistently for training purposes in the field or classroom.

Higher education is faced with the challenge of training preservice as well as inservice teachers to present a consistent professional image that reflects the highest standards possible in keeping with contemporary school district policy. It is imperative that teachers develop and maintain proficiency in the effective use of communication skills when dealing with parents, colleagues, and administrators. This proficiency is essential in order to eliminate or reduce miscommunication which may impair the ability of a teacher to work effectively with others.

At the present time the experience and training of teachers to deal with these communication demands is varied, inconsistent, or even nonexistent. The specifics of communication skills are not formally addressed in teacher education classes. Furthermore, the professional rarely receives any training about communication skills while working in the field. With the emphasis in teacher training on content-related areas, there is usually no room in the curriculum for more pragmatic concerns such as communication skills. The preservice teacher is often placed in the field with no background in how to deal with specific communication challenges. Additionally, there is little time in the school day for teachers to participate in inservice training that requires them to be away from their classrooms.

This training challenge is compounded by the fact that by restructuring the concept of regular and special education, teachers must now deal with students who represent a wider range of abilities and needs. The parents of these students may also exhibit expectations, needs and demands that are not compatible with the teachers' common communication experience and expertise. With a broader spectrum of personalities and personal objectives, the climate exists where more challenging communication interactions can transpire. As new avenues are explored with an expanding

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student population base, the likelihood also increases that additional communication skills may be needed to deal with anxieties, concerns, and unrealistic expectations that might occur in conferences and meetings. There is a need for strategies to be developed to enable teachers to communicate district policy clearly and consistently to parents in a professional and diplomatic manner.

Objectives of the project

The objectives of the project are:

- To teach professional educators basic communication skills.
- To present strategies for the professional to use when communicating with parents with different backgrounds and needs.
- To present strategies that are consistent with district policy for use in difficult situations.

Description of the Project

Needs Analysis

This project addressed the development of courseware materials for the purpose of training preservice and inservice teachers basic communication skills and strategies for communicating with parents of public school-aged children. The plan for executing a needs assessment included an analysis of both the content and the tasks in order to identify discrepancies and needs that the instruction could address (Seels & Glasgow, 1990). This data collection involved a three-prong approach where information was gathered from three different target groups: the teachers, building principals and central administration. Each group was administered questionnaires that focused on information and attitudes toward various aspects of parent-teacher communication. Representative members of each group were also selected for interviews in order to obtain more indepth information.

Analysis of the data gathered revealed commonalities in a number of areas that were important to the focus of this project. In triangulating information from the three groups, a consensus of important elements was established which suggested that:

- The formalized training provided in teacher education programs and inservice training has been minimal and inconsistent. There has not been standardized or comprehensive instruction in this area.
- There is a need for more clearly defined district policies and procedures for dealing with situations that are difficult or challenging. Clarification of a common plan of action allows all parties involved to participate in the communication process with more assurance that their interactions are appropriate and support the common goals of the district.
- Parent-teacher communication is essential in developing and maintaining a solid, supportive learning environment. Further instruction in this area would be valuable in making teachers feel more confident and effective in communicating with parents.
- Common communication problems were identified that were either directly experienced by the respondents or were anticipated by them as potentially realistic scenarios which may be encountered in the future. These communication problems were categorized into general patterns of behavior by parents who demonstrated such traits as hostility, manipulation, defensiveness, violence, unrealistic expectations and anxiety.
- Specific strategies were identified that addressed dealing with and resolving difficult situations. The strategies included numerous verbal communication skills, effective vocabulary usage, documentation and record keeping, and methods to diffuse emotional situations. The need for follow-up activities in these circumstances was also targeted as an important component in supporting and sustaining the communication process.

Based on analysis of the data collected from the different perspectives of the teachers, principals, and administration, three basic elements were identified that had to be addressed by the courseware. First, common communication problems were identified that were either experienced directly or could potentially present a problem in the future. Second, common strategies were identified that had proven to be successful in dealing with communication problems in the past. In instances where strategies were not apparent or effective, a review of the literature on parent-teacher communication provided the necessary information (McConkey, 1985; Simpson, 1990). The third element identified was that the strategies selected for dealing with various communication problems had to be congruent with the district policy and expectations.

Identification of media and delivery of instruction

The courseware materials include an instructional manual, computer software and an accompanying videodisc that provides tutorial instruction and practice in simulated experiences. The simulations are representative of different types of communication situations that teachers may experience on the job. This courseware is designed as stand-alone materials that can be used by professionals or preprofessionals individually and during more than one session if necessary. By training professionals in strategies designed to avoid or diffuse unpleasant experiences that they may encounter, these materials assist in optimizing the effectiveness of interactions with parents. The instruction addresses information that identifies nonproductive and ineffective communication as well as suggestions and activities that allow for success.

Use of interactive instructional media has well demonstrated the effectiveness of providing the learner with real life experiences while in a simulated environment. Interactive videodisc applications have been documented as a successful teaching method for preservice and inservice teacher training (Dalton & Hannafin,1987; Goldman & Barron, 1990).

Through this type of interactivity, instruction is possible that allows for examination of situations or events that would either be difficult or impossible to recreate in an actual classroom environment. The simulations permit experimentation with various encounters while also maintaining a sense of security and discretion. The teachers are afforded the opportunity to explore interactions with a wide variety of communication experiences that can be expanded as the training needs dictate. In a relatively short period of time, teachers can gain experience and knowledge of a range of communication problems that would not be possible to experience in the natural course of actual job experience.

The use of individual tutorials and simulations can enable the individual staff member to learn the information in a manner that is both private and confidential. This approach maximizes the learning situation in that the staff member may participate in learning activities in a nonthreatening environment that allows for exploration of new ideas without publicly receiving evaluation or criticism of their current expertise in communication skills. Thus, the opportunity for possible embarrassment can be minimized, and sensitive issues can be addressed in an environment that fosters encouragement and acceptance. The utilization of these interactive materials will provide realism to the simulation that approximates real-life occurrences. This instruction can also be replicated in a standardized manner throughout the school year for any professionals who are either required to participate in the training or merely desire to enhance their communication skills.

Prototype development

The instructional manual for the package contains background material related to basic communication skills. Included in the topics addressed are the necessary components of the communication process, effective listening skills, barriers to communication, communication styles and strategies for dealing with difficult situations.

A tutorial software program was developed based upon the needs analysis data. This software program also provides simulation exercises that allow learners to apply the information presented to common communication problems that have been identified. These simulations are representative of the types of scenarios and personalities that a professional may encounter in an educational setting. After participants respond to particular situations, the software branches to various consequences and solutions that commonly occur in actual conferences and encounters. The program includes features that provide reinforcement and feedback that explain the appropriateness and effectiveness of a chosen response. Suggestions for follow up activities are also provided to maintain the concept that communication is an ongoing, dynamic process that must continue to be supported and nurtured.

A videodisc is being developed that will accompany and enhance the software tutorial. With this technology, more sophisticated and advanced information may be presented (i.e., nonverbal communication, gestures, facial expressions) that is not practical with the computer program alone. The use of this interactive technology will give the learners real life exposure to situations that are representative of what they may encounter on the job. The videodisc will complement as well as expand the simulations that are provided in the software package.

Evaluation of the project

The software package is in the process of formative evaluation which includes pilot and field testing. The target population for this testing includes teachers in the Fox Chapel Area School District in Pittsburgh, Pennsylvania, who are in the district induction program, the teacher improvement program or who volunteer to participate to update their communication skills. Preservice and inservice education students at the University of Pittsburgh and Duquesne University will also participate in the field testing. Additionally, the project is being evaluated by the students in the Program of Communication at La Roche College in Pittsburgh, Pennsylvania, for communication effectiveness.

The evaluation data gathered includes pre- and post-test information, debriefing interviews of participants, and an exit evaluation of the program. Based on results of field test information, revisions and modifications will be made to further enhance the instructional package. The Fox Chapel Area School District administration will also have an opportunity to review the program and respond to its effectiveness and accuracy in presenting and supporting district policies and practices.

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Differentiated Use of a Lesson Planning Simulation

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Teacher educators new to the field of technology in education often view the use of any technology as an add-on to an already well-developed syllabus. This paper argues that computer simulations are better viewed as methods for enabling students to develop deeper concepts related to teaching and that the placement of a simulation within the teacher education program depends upon the structure of the program and the needs of the teacher education students. As an example we cite our developmental work with a simulation — Planning Lessons Using Simulation (PLUS)— used in two very different programs.

The Novice and Lesson Planning

Berliner (1986) suggests that lesson planning is a complex series of decisions based on knowledge that experienced teachers have internalized. He says that experienced teachers and novices are different because the novice does not have that knowledge. We tend to teach lesson planning in a linear manner, but early research suggests that planning is a recursive process during which teachers make decisions about content sequence, grouping, classroom activities, evaluation procedures, and use of instructional time (Sunal & Haas, 1989). Copeland (1989) proposes the development of a class of interactive, technology-based simulations to help students develop "clinical reasoning." Clinical reasoning is "thought processes that precede purposeful teacher action" (p. 10). Copeland's assumptions are: (a) reflection is essential in developing clinical reasoning; (b) to be able to reflect, there much be an experience sufficiently rich to give something to reflect about; (c) carefully constructed simulations can provide a rich experience. Further Copeland states:

> Simulations allow trainers to distill the variety of clinical events novices normally experience over lengthy periods of actual work into a concentrated and controlled set of practice encounters. This distillation can be used to increase the rapidity by which the knowledge structures that are the basis of effective clinical reasoning can be developed (p.12).

What makes the use of simulation so powerful is not just the technology, but the human element in the debriefing that follows the simulation. Raths (1987) talks about the value of debriefing in learning:

> Debriefing gives students relatively free rein to organize, compare, classify, evaluate, summarize, or analyze and experience. The product of the debriefing process is an articulated sense of 'meaning.' It is through this process of constructing personal meaning that students reveal their misunderstandings, oversimplifications, and personal theories (p. 27).

Raths suggests activities to help with debriefing including writing log/diaries, writing a precis, naming themes, imagining alternative endings, evaluating, role playing, drawing, comparing, or concept mapping.

PLUS was created to assist students in developing the relevant knowledge that leads to understanding and using the steps in a teacher-directed lesson.

Rationale

Because of early successes in the use of simulations in our teaching (Brent, Willis, & Beacham, 1992; Willis & Willis, 1991) we both felt that it would be beneficial to develop a series of simulations specifically for teacher education. While our long range goals include the development of a number of simulations focusing on delivery as well as planning of different types of lessons, we decided to focus on Madeline Hunter's direct instruction model for several reasons:

- Planning and writing lessons are difficult activities for most beginning education students. Both authors spend a lot of class time helping students develop the expertise needed to begin to practice on their own.
- The direct instruction model is often the first taught and is probably the most straightforward.
- Both North Carolina and Texas use teacher appraisal instruments based heavily on the direct instruction model.

Description of PLUS

PLUS takes the student through the planning and writing of one direct instruction lesson plan including the selection of materials. Students are given a description of a third grade language arts class and the topic of the lesson. Throughout the simulation students are asked to choose from among a poor, a good, and a better selection at each decision point. At critical points in the simulation students are given a "reality check" based on actual classroom experiences of the authors. For example, students must decide how to respond when, during a brainstorming session, a child suggests something totally off-the-wall. At each decision point students are given feedback on their choices. Throughout the simulation students have access to pull-down menus that provide tutorial information on the different parts of the lesson plan and reminders of selections they've already made.

Despite the fact that we created the simulation together we neither use it in the same manner nor at the same stage in our students' development. The following describes our two different applications of the simulation.

ECU Program Use

At East Carolina University, PLUS is used in the first methods courses taken by students in their junior year. A special section of 25-30 students co- enroll in a general methods course and a language arts methods course.

The linked courses have the following characteristics:

- Courses are scheduled back-to-back resulting in a four-hour block of time twice a week throughout the semester.
- Instructors team to deliver instruction using flexible scheduling and joint presentation of shared topics, such as lesson planning and assessment strategies.
- Students are videotaped as they microteach a language arts lesson early in the semester and at the end of the semester. Both taping sessions are followed by self-assessment, peer evaluation, and instructor conferences.
- In teaching teams of three, students plan and teach a series of ten related lessons to a small group of children enrolled in an after school tutorial program.
- PLUS is used as a tool to assist students in their understanding of lesson planning.

The instructors team teach a four-hour session on lesson planning beginning with a demonstration of a teacher-directed lesson. After a discussion of their observations about each step, students work in groups to assemble lesson plans from separate components and to write their own simple lessons. It is at this point that PLUS is first introduced. A demonstration in class introduces the students to the basics of using PLUS including how to start the program, use of the mouse, and how to quit.

Then each team of three students receives a disk containing PLUS they can use over the next two weeks in any way they choose. Some groups go through the program as a team, discussing the decision points and trying different responses. Other teams work through the program individually or try a combination of group and individual work. After a week, time is spent in class debriefing the simulation. The students talk about how they felt as they worked through the simulation and they generate questions and talk about other uses for the material they learned. The next week, teams turn in the disks and complete a questionnaire and quiz on the material.

Since PLUS is used early in the introduction to lesson planning, students are able to learn details about the steps, evaluate and select steps, and think about what will happen when the plans are implemented. PLUS makes lesson planning come alive in a way that simple lectures or even class activities cannot. Students may not absorb all that PLUS has to offer due to their own limited experiences. However, it lays a good foundation which affords them the possibility of deeper understanding as they gain experiences with teaching.

UH Program Use

Interns in the Teachers For Tomorrow program, sponsored jointly by the University of Houston, Houston Independent School District, and the AT&T Foundation, are field-based for approximately one year. Students admitted to this special program spend approximately 30 hours a week, including two hours of seminar, in a public elementary school. They rotate among a number of classrooms at every grade level, pre-kindergarten through fifth, in every ancillary class, and in the school office. Interns begin by observing, but quickly are asked to teach small group and whole group lessons. During the first semester they also take six hours of methods courses, leaving the school to attend classes Monday and Wednesday afternoons. By the time interns move into student teaching, usually during the second semester, they have a richer knowledge of the myriad of duties, pains, and pleasures that impinge on teaching.

The school is very much an inner-city school with all the attendant problems including lack of funding for technology. Because very little technology is available seminars are held on campus at least once a month in the UH Classroom of the Future (COF). With technology readily available software applications are modeled for the interns, and the integration of technology discussed. For several semesters the interns have used PLUS, but at differing times in the semester. The first group used the simulation very early in their first semester. In one seminar direct instruction was the focus with modeling followed by discussion and small group work to give students an overview. During the second week the seminar was held in the COF where students went through the simulation followed by a debriefing. The next group of interns were not given PLUS until near the end of their first semester. The debriefing focused on relating parts of PLUS to interns observations and experiences during the preceding weeks. This proved to be a better placement for the interns for a number of reasons.

The majority of the first group had few classroom experiences observing, in a clinical manner, a direct instruction lesson. Their background information was often naive and many nuances implied in the simulation were overlooked. While interns termed the simulation *nice and informative,* subsequent course requirements demonstrated that many had unclear concepts. PLUS may have actually added to their initial confusion. When this group went through the simulation they were just beginning their methods courses. These are taught two at a time in five week blocks, with each methods instructor putting a different 'spin' on lesson planning, but with an overall constructivist approach. The constructivist view of designing lessons tends to leave naive students with the idea that all direct instruction is undesirable, but they also know that if they are going to teach in Texas they will be expected to demonstrate proficiency in direct instruction. This dichotomy– the philosophy of Schon's reflective practitioner and constructivism *versus* the reality of public school requirements – causes conscientious students a high level of stress. For beginning interns this created too much dissonance. The more experienced interns have not only learned to design and teach student-directed lessons, they have witnessed, and reflected on, a number of lessons successfully taught in a variety of ways. At this point PLUS helps them to consolidate what they've learned about lesson planning in the methods classes with what they've learned in the field, and they begin to explore ways to meet administrative requirements while serving the needs of their students. PLUS becomes a stimulus for discussing not only planning, but what to do when the plan goes astray. The *reality checks* provide a focus for advance reflection. As part of the reflective practice we encourage our students to think *what if,* to reflect not only in action and on action, but pre-action! By asking our students to think *what if — what if none of the children respond?—* we help them to become reflective practitioners, ready for other real-life teaching scenarios.

Summary

At East Carolina University teacher education students build a foundation for lesson planning using PLUS. At the University of Houston PLUS helps students bridge the gap between theory and practice. PLUS is thus used in different ways at the two institutions, but both uses are suited to the particular program and individual developmental needs. PLUS and the debriefing that accompanies it help provide the stimulus for necessary growth in the area of lesson planning. The differentiated use of PLUS illustrates the general point that is often overlooked when integrating technology resources into teacher education: *when, how,* and *why* the technology is integrated is more important than *what* technology you integrate.

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TECHNOLOGY PROJECTS

**Section Editor:
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Efforts towards Programmatic Change

Ongoing efforts to better integrate technology as an effective tool for instruction in schools across the country continue. These attempts are not new. Small steps toward success can be seen in pockets throughout this country and abroad. What has become clear is that the cost in time and effort of existing projects has not produced the hoped-for quality of change.

One of the realizations that has grown out of the efforts that have taken place is that the practitioners in the schools are only one of the many audiences that need support if we are to prepare students in classrooms to be productive citizens in the 21st century. Faculty in schools of education, preservice students and classroom practitioners all need help as they develop the knowledge and strategies needed to implement technology into their own teaching. It will take the efforts of many to accomplish this monumental task. It is unlikely that any of us alone can accomplish our goal. Working together in collaborative partnerships of many kinds may be one of the keys towards greater success in these projects.

The twelve papers in this section represent a variety of efforts toward helping members of each of the groups mentioned. The majority of papers fall into one of 3 categories: supporting practitioners — partnerships for change; supporting practitioners — university projects; and supporting faculty — schools of education integrate technology. The papers by David-Hanson and Johnson and McMahill are unique.

David-Hanson reminds us that whatever the partnership or project to incorporate technology as an instructional tool, it is necessary to begin with the teachers' concerns and attitudes towards the changes we are asking them to make. This paper suggests examining the value of using the Myers-Briggs Type Indicator as a tool for designing professional growth activities and for matching facilitators with the participants in their workshops.

The Johnson-McMahill paper begins an examination of the complex issues surrounding diffusion of innovation research. The model described was meant to introduce multimedia technology and constructivist instructional strategies into the high school classroom. In addition the authors were attempting to identify key variables from diffusion of innovation research that would increase the probability of affecting change. Their early findings have implications for all who are designing projects to bring into school settings.

Supporting practitioners — Partnerships for change

Four of the papers describe partnerships across several agencies to provide opportunities for school-based practitioners to increase their skills in using technology in the instructional process.

Baumbach, Bird and Brewer describe a partnership which includes the university, business, and the state department of education. This partnership has been ongoing and continues to pursue a multifaceted range of technology

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support for educators in the state. Each of the partners strongly believes in a continued focus on providing more professional development opportunities for teachers. As the authors point out in their conclusion a partnership such as this provides more resources, more support and more training for teachers across their state than any one partner could have provided alone. This model provides valuable suggestions for us all.

Cowley and his colleagues from South Africa describe the early stages of introducing both teachers and students to the broad range of ways in which technology can become a valued tool in their educational settings. Partnerships between the university, the provincial educational departments and local school districts provide opportunities for students and models for their teachers that can be locally implemented. Another goal of this project is to make educators aware of the professional growth opportunities at universities that will enhance their own professionalism. Implementation of this plan is costly in both dollars and time but initial results with students are encouraging to both the students and the educational community.

The partnership between McREL (Mid-continent Regional Educational Laboratory) and local schools is described in the Fanning paper. One technology based project from the agency was involved in efforts toward school restructuring. Fanning describes a technology partnership with two local schools aiming in that direction. This is a powerful paper that reminds us that even with a well-designed project and the best of support, results may only help us to learn how to do it better the next time. The best of partnerships is dependent upon the internal support within the individual school settings that are involved. Strong external support and the interest of students and a few enthusiastic teachers are not enough to move the school forward. Key issues of importance to educators planning partnerships are identified in this paper.

The Staudt paper also describes the results that can emerge from a partnership. In their partnership with a Texas Educational Agency this university has established a technology classroom that can help teachers to use, understand, and employ technology in the working environment. Designed to be a training ground for university faculty, preservice students and classroom teachers, the site provides opportunities for all groups to look at strategies of classroom integration as well as telecommunication, distance learning, video conferencing. As educators we will look forward to the results that follow the implementation of this exciting facility.

Supporting practitioners — University projects

The Train the Trainer model described by Benavides and Surrey prepares preservice faculty to model the uses of computers and other technologies. Institutional support provides training for those who will become a team of trainers working and partnering with colleagues. The cooperative model adds a special dimension. In the long term this group plans to continue the training process as new technologies emerge and to foster innovative uses within classroom settings.

The developmentally appropriate use of computers with young children is the focus of the Technology in Early Childhood Habitats (TECH) program at the University of Delaware as reported by Caruso, Trottier, and Shade. Preservice and inservice teachers who successfully complete this program are capable of and confident in the use of technology as an integral component of their early childhood program. This model consists of three fundamental elements: theoretical foundation, hands-on practice, and constructive evaluation.

Two papers in this section describe university projects that recognize the need for school of education faculty, preservice students and current practitioners to become familiar with the various technologies and ways in which they are used in classrooms. While each project takes a different approach each has also been successful in the context for which it was designed.

The project at the Anahuac University in Mexico City focused on developing software to support the teaching of mathematics in elementary school. Machuca and colleagues realized that the success of the project was highly dependent of the role of the teacher. They have also designed a set of three courses that would prepare the teachers to partner with them in using the software in the most effective manner. At this time the group has not provided a description of the implementation of their plan. This process and the accompanying results will be of value to other educators and we can look forward to hearing more from this group in the future.

The National Center for Technology Planning at Mississippi State University has been developed as a resource for schools all over the country that are preparing and implementing school or district based technology plans. The Anderson and Perry paper provides a clear picture of the steps a planning committee would be wise to follow as well as listing resource suggestions, beyond the Center, that would be helpful. We can hope that Anderson and his colleagues are collecting data from those who are taking advantage of its resources and strategies in the planning process. Hearing from those who have completed developing and implementing their plans would be of value to others who are moving in that direction.

Supporting faculty — Schools of education integrate technology

Several papers in this section describe faculty development plans in schools of education. If preservice teachers are going to enter schools ready to use technology in their own classrooms they need to have opportunities to use the technology in the programs and to see their own instructors model the ways in which technology can be an instructional tool.

The professional development plan described by McKenzie and Mims was implemented through a series of voluntarily attended workshops. This extensive series was advertised throughout the university and local schools.

Benefits to both university faculty and schools in the area were documented at the end of the project. The results included future changes that will be of value to this project in the future and to other institutions wanting to make efforts in this direction.

The need for support for faculty in the School of Education was recognized earlier at Iowa State than at many other institutions. Thompson and Schmidt focus on one component in the third year of a planned program for faculty development. This paper describes a series of computer-related technology experiences in foundations, methods and field experience classes. The results of their approach shows that technology has become an important tool for the teacher education faculty for both personal and instructional use.

Conclusion

Each of the papers in this section reaffirms that we are all in this effort together — but there are many different approaches to help us attain our shared goals. Factors important in effective professional development programs have been considered by those who designed the projects and noted by the authors of the papers. Duttweiler (1989) lists context, administrative support, opportunity for choice, content and training design as keys to success. As the reader will see the importance of each of these elements emerges in the twelve papers. Further, the importance of collegial working relationships between faculty members in professional development (Bas-Isaac, 1992) has also been considered and included in several of the projects described in this section. Clearly time is an issue to be considered for successful implementation of a technology project. The Iowa State and the University of Central Florida projects demonstrate the importance of on-going, sustained implementation plans. Keeping in mind that change is a process not an event will make it easier for us to maintain the patience needed to prepare educators in all settings to use technology as meaningful instructional tool.

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Doing More with Less: A Cooperative Model that Works

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Many schools, school districts, state departments of education, and colleges of education are all trying to do more "technology" (more teaching about technology and more teaching with technology) with limited resources. Software producers and hardware vendors are finding it difficult to meet the demand by educators for training, information, and product support. A cooperative model has evolved in Florida at the University of Central Florida which benefits Florida educators and all partners, and which we feel is replicable and worthy of consideration.

The Instructional Technology Resource Center

The Instructional Technology Resource Center (ITRC), now beginning its 13th year of operation, is the result of a unique partnership between the Florida Department of Education, Florida public school districts, UCF's College of Education, and a number of business partners. The partnership has resulted in benefits to all, and all partners are responsible for the support and maintenance of the Center.

The mission of the Instructional Technology Resource Center is to support school improvement efforts related to technology and to support current state technology initiatives. The mission is carried out through a variety of resources and services which are available for both preservice and inservice teachers as a result of the partnerships.

Resources and services

Thirteen years ago, the initial focus of the ITRC was to provide information about computer literacy to Florida educators. The ITRC staff , involved in helping to define Florida's student minimum performance standards for computer literacy, supported teachers who were helping students achieve the standards through a series of brochures, *The Parent and the Public Series*. These brochures included such topics as *What is computer literacy?*, *How can the computer help my child in math?*, *Does my child need a computer at home?*, *Where can I find good software for my child?* and more. The ITRC also produced a videotape acquainting Florida educators with the minimum performance standards and provided instructional materials for the student minimum performance standards to every school.

Publications

Since the beginning of the ITRC, a quarterly newsletter has been published. Originally, the *Printout* was mailed only to district technology contacts. Recently, the title was changed to *Connections*, and is currently mailed to each contact, to each Florida school, and to a mailing list of over 3000. The content has changed from providing information about the ITRC and its activities to including information on topics of current interest. Two regular columns now appear, one authored by Dr. Fred D'Ignazio, a consultant to the ITRC, on multimedia, and the other by Eileen Pracek, Director of the Florida Diagnostic and Learning Resources Services Technology Project, on instructional technologies appropriate for different learning modalities. The newsletter announces new products from business partners, upcoming

ITRC events, and other news of interest to Florida educators.

Other regular publications include *Innovations and Innovators,* a newsletter by and about Florida's Model Technology Schools (MTS). The quarterly publication, mailed to every Florida school, highlights successful programs in the MTS, generally concentrating on a topic of interest such as retrofitting, videodiscs in instruction, or accountability. Through this publication the five MTS facilitators share information about their own experiences and what they have learned with other Florida educators. In addition, the ITRC publishes the annual *Model Schools Report,* a status report on the MTS goals and accomplishments for distribution by the MTS schools.

A spin-off of the *Connections* newsletter, *Connections Live!* first appeared in schools in fall of 1993. A quarterly video news magazine, *Connections Live!* is a fast-paced program which features Florida teachers and students who are teaching and learning with technology. The 30-minute show, hosted by Florida's Teacher of the Year, is uplinked to Florida schools and school districts. The program is followed by a one-hour period during which Florida educators can call a toll free number and speak to the teachers and students featured on the program. *Connections Live!* may be taped and distributed throughout the state via satellite, cable, microwave, or videotape.

An annual publication, *The Great Florida Educational Technology Catalog,* is produced by ITRC staff for distribution at the Florida Educational Technology Conference. *The Catalog* is probably the most comprehensive compendium of information about Florida's instructional technology-related initiatives. Short articles describe current projects and list contact names for each project. *The Catalog* also lists district contacts and phone numbers for instructional technology, management information services, instructional television, and educational media. FDOE contacts related to technology are also provided. Each school district is surveyed regarding the status of technology in the district, as is each community college and college of education in the state university system. The results are reported on a grid which allows districts quick access to information. Two other popular features of *The Great Florida Educational Technology Catalog* are "Florida Says" and "Art Contest Winners." "Florida Says" provides the results of a survey of Florida's technology using educators which asks them to respond to categories such as "programs you couldn't live without," "best speaker at a technology conference," "best uses for old hardware," and "things you would like to tell the legislature about technology." The section of the catalog on "Art Contest Winners" reproduces grade level winners in the Center's annual art contest. Students are encouraged to participate in depicting technology through computer-generated art or through traditional media. The grand prize winner's artwork is featured each year on the official poster of the Florida Educational Technology Conference (FETC). Business partners may cosponsor the event, and the winner's school receives a prize and the student receives a trophy and recognition. An autographing party at (FETC) has become a popular event.

The ITRC provides resources for training educators about technology. For example, *Training Wheels,* a packet of resources for teaching about videodisc technology, has been one of the Center's most popular products. *Training Wheels* is a compilation of activities and resources the ITRC staff have found useful in training teachers to use videodisc technology, both Level 1 and Level 3. *Training Wheels* includes outlines for workshops of varying lengths—from two full days to half a day to no time for a workshop—along with materials needed to conduct those workshops. Print resources include brochures, overhead transparency masters, an issue of the *Printout* which can be used as a basic text, ideas for using barcodes with videodiscs in the classroom, outlines, descriptions of disk files, and directions for all activities. Non-print (disk) resources are available for MS-DOS, Macintosh, and Apple IIgs and include a tutorial, a presentation stack, templates, and a barcode generation program. All materials can be reproduced for educational use. *Training Wheels* is available at no cost to educators; however, the ITRC does request two blank 3.5" diskettes to help defray the cost of the package.

Technology support for educators

Other ongoing activities of the Center include a toll-free "hot line." An 800 number (Florida only) was installed several years ago to support a state initiative which provided a videodisc player for every public school in the state. The toll-free number was used to ask questions of ITRC staff about any difficulties they had in using their players. The 800 service is very popular with Florida educators and has proved to be one of the most cost-effective services we offer. Voice mail has been added so that educators can leave a message virtually 24-hours a day. A member of the staff returns the call as soon as possible and provides the needed information or refers the caller to another source.

A preview and evaluation center has been established at UCF for public school educators. Teachers can come to the ITRC to preview hardware and software including CD-ROM and videodiscs. Cd-rom and videodisc programs can also be checked out for one week to preview in the classroom with students. The programs can be mailed to schools; the school must provide return postage. It is not unusual for educators to request that several multimedia encyclopedias be set up side-by-side for comparison, for example, or to request to see two other similar products for their own evaluation.

During the last year, the university made available to the ITRC a 2000+ square foot facility for preview and training. The space was remodeled to accommodate technology and training. Teachers call for an appointment to visit the ITRC for preview, and staff is available to assist them in loading software or operating equipment. Many schools have released teams of teachers for a day or half-day periods to come to the ITRC for preview.

The MMTRDC

Currently known as the UCF/DOE Multimedia Training, Research and Development Center (MMTRDC), the space is equipped with a wide variety of equipment for multimedia products and development. Both low-end and high-end equipment is available, including scanners, digitizers, color printers, sound and image libraries, video and audio capture devices and more. All equipment and software was provided by business partners. The facility is used by the ITRC to train teachers in basic and advanced multimedia as well as in a variety of business partner products appropriate to education. Our business partners use the facility for training of teachers, administrators and staff. UCF College of Education faculty may also schedule the facility and its resources, including staff if necessary, and College of Education faculty and full-time graduate students can attend MMTRDC workshops free-of-charge on a space available basis. Currently workshops are scheduled in basic multimedia, advanced multimedia, Microsoft *Works*, Microsoft *PowerPoint*, and *HyperStudio*. Product preview days are scheduled for many business partners including MECC, Broderbund, Microsoft, and others.

The facility is also used for teleconferences, "teleshops," and "telecourses." The facility is wired for two-way video and with two telephone lines. A technology course featuring U. S. Teacher of the Year, Floridian Tracey Bailey, and Dr. Fred D'Ignazio is currently in the planning phase and is expected to be delivered via satellite in the spring of 1994. In the fall of 1994, "teleshops" will be uplinked to Florida subject area conferences around the state from the MMTRDC. Most conferences, such as social studies, science, math, and English, are scheduled on the same days in the state; the MMTRDC facilities will allow us to present sessions at each conference without leaving the facility. In addition, a number of seminars featuring Florida educators who have successfully used technology, are planned. These may be uplinked as well.

The focus for the immediate future is on training, since that is the area of greatest need. However, it is anticipated that the MMTRDC will also be used for research and development in the near future. Several projects in each category are already underway. Two doctoral dissertations have been completed using the resources of the MMTRDC, and several products are under development by UCF faculty and students.

The TechTeam

The ITRC staff was expanded during the last two years to provide "grass root" support for teachers who are trying to integrate technology into their own curricula. A team of six teachers who had successfully integrated technology into their own classrooms, the Florida TechTeam, were hired last year and strategically placed throughout the state to provide school-based support for technology. Their activities are coordinated through the ITRC, but they remain based in a school district or university and communicate via FIRN. TechTeam members may provide inservice training for large or small groups of educators. They may teach demonstration lessons or work one-on-one with another teacher. They may provide any kind of service which supports technology in a school; however, no one can be required to attend a TechTeam member's sessions. Teachers must attend voluntarily. The team expanded to eight this year. A ninth member with skills in exceptional education and assistive and adaptive devices was hired as a resource to the team of eight. In addition, four similar staff members have been hired by educational consortia in the state to provide additional support. This has been a very successful initiative.

The partners

The project partners provide critical resources and input to the Center, and the Center could no longer function without the cooperation of all four partners. All partners receive benefits as well. A memorandum of understanding exists between the Center and the Florida Department of Education as well as with each business partner (See Figure 1).

Florida Department of Education

Funding for staff, travel, supplies, printing, postage and general administration is provided by the Florida Department of Education (FDOE). Four separate divisions are directly involved in funding: The Bureau of Educational Technology (BET), Florida Information Resource Network (FIRN), Florida Remote Learning Services (FLRS) , and the Bureau of Exceptional Education Services (BEES). The Division of Public Schools (DPS) provides funding for an additional technology-based project housed within the Center.

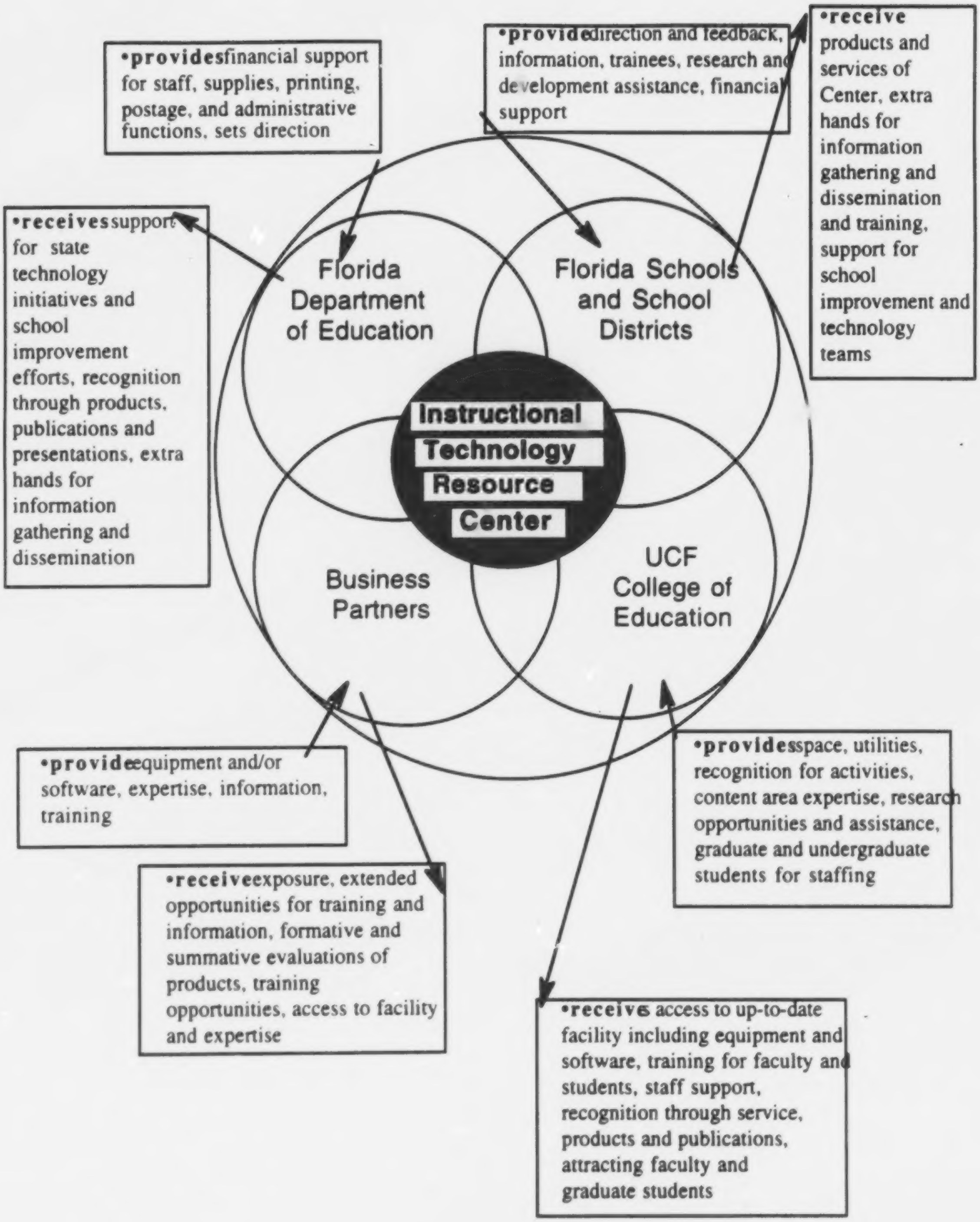
BET is the division which directly supervises the project and is central to all state technology initiatives as well. Current initiatives include retrofitting, software acquisition, product co-development with a number of companies, school improvement initiatives, and the Florida Educational Technology Conference.

FIRN is the statewide information network which provides free electronic mail to all Florida teachers, data transfer between school districts and the FDOE, transcript delivery from school districts to state community colleges and universities, internet access, technical support and training, and more. FLRS is a new office which is designed to promote and enhance distance learning activities in Florida. BEES provides services for all exceptional students through a statewide network, specialized centers, and technology initiatives.

The Florida Department of Education provides the focus and direction for the Center and its activities. As seen from the activities described above, the focus has changed and broadened over the years, as the needs of Florida educators have changed. In return, the Department receives extra hands to carry out its work. The ITRC has produced research reports and literature reviews for the DOE upon request. In addition, the ITRC publishes articles in national and state journals and presents papers and workshops at state, regional, national and international conferences, promoting state technology initiatives and the activities of the Center and, hopefully, enhancing the image of the state.

Schools and school districts

The 67 Florida school district instructional technology contacts (one per school district) are the primary contacts for the Center. A subgroup of these contacts, along with representatives of several business partners, comprise the


Florida Department of Education
Florida Schools and School Districts
Instructional Technology Resource Center
Business Partners
UCF College of Education

•provides financial support for staff, supplies, printing, postage, and administrative functions, sets direction

•provide direction and feedback, information, trainees, research and development assistance, financial support

•receive products and services of Center, extra hands for information gathering and dissemination and training, support for school improvement and technology teams

•receives support for state technology initiatives and school improvement efforts, recognition through products, publications and presentations, extra hands for information gathering and dissemination

•provide equipment and/or software, expertise, information, training

•provides space, utilities, recognition for activities, content area expertise, research opportunities and assistance, graduate and undergraduate students for staffing

•receive exposure, extended opportunities for training and information, formative and summative evaluations of products, training opportunities, access to facility and expertise

•receives access to up-to-date facility including equipment and software, training for faculty and students, staff support, recognition through service, products and publications, attracting faculty and graduate students

Figure 1. Cooperative model for extending resources and services to Florida educators.

Center's advisory board which provides input on products and services, evaluates the Center's progress, and assists the DOE in determining activities of the Center. Districts provide time for contacts to work with the Center. All district contacts are surveyed annually by the Center for a status report on technology in their districts. The report is published and issued to all technology contacts, district superintendents, and others interested in technology initiatives in Florida. School district contacts receive all products of the Center and the right to reproduce them in total or in part as appropriate for their districts.

District contacts are also valuable sources of information for the ITRC staff. Frequently calls to the 800 number relate specifically to district initiatives, and only contacts can provide the necessary information. District contacts are also supportive in working with business partners. Many new business partners have been referred to us by district contacts who value the work of the ITRC, and business partners often report that a school or district has made a purchase because of seeing the product or using it at the ITRC.

Florida schools provide release time for teachers to visit the ITRC, and they provide funding for fee-based workshops help at the ITRC/MMTRDC from school improvement or technology funds. These funds are used to support student staff at the ITRC.

Business partners

Business partners provide hardware and software for the Center's use in training and for the preview and evaluation center. To date, over twenty business partners are participating including Apple, IBM/Eduquest, Roger Wagner Publications, Microsoft, Bell South, Optical Data, Paramount Publishing, BFA, MECC, Pioneer, Synsor, Davidson, Broderbund, Wings for Learning/Sunburst, and others. In return, the partners receive products and services. Pioneer, for example, is distributing components of *Training Wheels* in their own training for educators. Several companies have received written and comprehensive formative evaluation reports on the alpha and beta versions of new products.

Partners may also use the facility for training. Several companies conduct training with their products for educators; other companies have used the facilities to train their own sales staff and to introduce them to new products. Most business partners report that having access to a large, well-equipped facility is one of the most positive benefits of the relationship.

University of Central Florida

The University of Central Florida, specifically the College of Education, provides space for the facility and staff. This is no small contribution since the scarcity of space on this campus is one of the most serious problems; in fact, a movie theater complex in a shopping center adjacent to UCF is used for classes each morning as are several local schools in the late afternoon and evening. In addition, UCF provides access to students for research and for student staffing. Faculty expertise in the content areas of education (social studies education, English education, science education, etc.) as well as in instructional design, instructional technology, school law, and educational research is readily available. Expertise is also available in related areas such as software and hardware design, computer science, engineering, and business from faculty and graduate students in other colleges. The reputation of UCF, its central location in the state, its proximity to a major airport and world famous area attractions draws students, faculty, and business partners alike.

In return, the college and university have access to the facility and to ITRC staff. Training opportunities are available for both faculty and students. Business partners are asked to reserve a slot in their training sessions for an interested UCF faculty member, and they have honored this request. ITRC staff are also available to consult with college faculty and to conduct training for students in their methods classes. In fact, one TechTeam member is assigned that responsibility on a half-time basis, with half of his salary provided by the college. Finally, the UCF College of Education, largely because of the existence of the ITRC and its activities and products, has earned a reputation throughout the state and beyond as a leader in instructional technology.

Summary

This paper has presented one innovative approach to providing more resources, more support, and more training for technology initiatives, that of partnerships. It is an approach which continues to serve all partners well, and one which is worthy of examination in other settings. Similar projects are underway at Pepperdine and Michigan State University and are based on the UCF project. We would strongly encourage other states to consider the benefits of such a project.

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Using a Schools Outreach Program to Develop Computer-Literate Teachers

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In this paper, the term "educational computing" is used as an all-inclusive and neutral concept, embracing all the modes of computer use in schools (didactic as well as administrative).

Few South African teachers have adequate skills in educational computing and a massive training effort in this field is needed. The Educational Renewal Strategy (ERS) (Department of National Education, 1992) and the National Education Policy Investigation (NEPI) (National Education Co-ordinating Committee, 1993) stress the need for teachers to be educated in the educational applications of information technology, although they are not very specific about details. These applications will help in restructuring the South African education system in order to correct past imbalances. This central or regional planning theme is explored by Bean (1994) in his paper "Computers in South African schools: Quo vadis?"

In-service training of teachers in educational computing is an important aspect of an enhancement program. This can be by means of a formal program of study, like the part-time Further Diploma in Education in Educational Computing offered at the University of Port Elizabeth (UPE). This particular program, its significance and its future is discussed by Bean and Cowley (1994) in their paper "Preparing educationally computer literate educators for the "new South Africa."

An alternative means of in-service training is that provided by educational authorities. An example of this is the joint educational computing project being undertaken by the four South African provincial education departments, Computers in Schools and Colleges (CISC). A project developed by the Cape Education Department. This project and its future under a government of national unity are discussed by Assheton-Smith (1994) in his paper "Getting computers into the classroom — a South African perspective."

An additional way of providing in-service training and educational research opportunities to teachers can be by involving them in a schools outreach program. This is starting to happen at UPE as a side effect of the UPE-Enthabeni mathematics project.

The UPE-Ethembeni Mathematics Project

Ethembeni Enrichment Centre in Port Elizabeth provides after-hours supplementary education in mathematics, physical science, biology and English for disadvantaged (but highly motivated) high school students. At present all of these students are Black. Students in standards 6 to 10 (8th to 12th grade) enroll for seven week long courses, each of which deals with one of the above-mentioned subjects. Enrollment is voluntary and the students pay tuition, although most of the operating funds for the Centre come from donors. From 150 to 300 students may enroll in any course. Courses are taught by outstanding teachers drawn from local schools. Ethembeni means "place of hope" and it has become a place of hope for many young people hungry for a good education.

Unfortunately, there are considerably more applicants for the courses than there are places for students. For this reason, Centre management became interested in the possibility of using computer assisted learning (CAL) to provide more effective education to larger numbers of students. Their initial rationale for wanting to use information technology was thus a pedagogical one (Hawkridge, Jaworski and McMahon, 1990).

The trustees of Ethembeni approached the UPE Department of Computer Science for help. A team made up of members of the Departments of Computer Science and Mathematics, and the Computer Centre, was formed to assist Ethembeni in selecting suitable CAL software, as well as providing advice on the practical implementation and management of CAL-based education.

Students from disadvantaged communities struggle with science and mathematics in high school. Thus a relatively small percentage of them take these subjects and pass examinations in them. Science and mathematics are prerequisites not only for tertiary education in science and commerce, but also for many technical fields. Because of the importance of mathematics and the mathematical background of the team members, the team decided, in consultation with Ethembeni, to study the effectiveness of CAL in improving mathematics knowledge and skills in Standard 9 (11th grade) students over a seven-week period.

Two experimental groups of students from Ethembeni were transported to UPE's Summerstrand campus by bus once a week each for a 3-hour laboratory session. One group came on Friday afternoon and the other group on Saturday morning. These were times when the laboratory facilities were unused. Each group used a different CAL system for their mathematics lessons. These lessons supplemented the coaching sessions in which they participated at the Centre.

The team compared the progress of these students with a control group who attended the coaching sessions, but did not have access to the CAL lessons. The groups were selected by stratified sampling (Gay, 1976) and were statistically equivalent. None of the students in the population were computer-literate. The most that some of them had done was play video games in an amusement arcade.

Teacher Involvement in the Project

During the study, a few teachers from Ethembeni and other schools became involved in the project as volunteers during CAL sessions. They were trained by the UPE team as supervisors of the CAL systems "on the job" and were considerably impressed by the educational possibilities of the system and the positive attitudes of the students towards CAL. One of them become so interested that he intends starting a Ph.D. in CAL-based mathematics education at UPE in 1994. Although the number of teachers who came was few, it was clear that here was an opportunity to add the catalytic rationale for computer use (at least partially) to the initial pedagogical rationale (Hawkridge, Jaworski and McMahon, 1990). This could only happen if the working relationship between UPE and Enthabeni was strengthened and given some permanency. A comprehensive plan for future co-operation was needed.

A Plan for the Future

Ethembeni and the UPE team met at the end of the seven-week period to discuss the qualitative and quantitative findings of the project. The results of the study showed that the use of CAL in addition to group classes significantly improved the mathematical competence and motivation of the students. CAL is clearly a viable option for Ethembeni and at the time of writing they are setting up the first computer laboratories for mathematics CAL, and CAL in the other subjects that they teach. The UPE team is supporting them in this with advice and technical help.

In addition, it was decided to continue the CAL project as a small schools outreach program for the rest of 1993. An additional class was scheduled for Saturday afternoons. The outreach program was a success and, according to feedback received from Ethembeni, the final marks of several students who were consistently poor at mathematics showed a dramatic improvement.

UPE also proposed to Ethembeni that the pilot outreach program be expanded into a full-blown schools outreach program, based initially on mathematics CAL during 1994. Enthabeni, with its excellent credibility in, and communication channels to, schools and organizations in the disadvantaged communities, would act as the interface between UPE and these communities. The computer facilities of the Department of Computer Science (160 microcomputers), which are not used over weekends and academic holidays, could be employed for additional CAL and basic computer literacy training for students from Ethembeni and similar organizations. This would strengthen the good work being done by these organizations to raise the general level of scientific literacy in this important group of highly motivated students.

The Ethembeni representatives were very happy with this plan and agreed to continue to work with UPE for the benefit of both institutions, and, especially, for the benefit of the Ethembeni students.

The Place of Teachers in the Plan

Teachers became involved in this plan in two ways. Teachers from schools in disadvantaged communities would be invited and encouraged to act as supervisors and assistants in the computing sessions, thus giving them an opportunity to observe how information technology can assist them in teaching more effectively and gain practical experience of this — an actualization of the pedagogic and the catalytic rationale. It is to be hoped that once these teachers start to become educationally computer literate, they would become part of a training cascade, or network, in schools in the disadvantaged communities (Hawkridge and Macmahon, 1992). This poses great challenges, because knowledge of computing and the availability of hardware and software in these schools is virtually nonexistent.

Once the programme is running, it would inevitably be an ongoing source of research projects on the use of computers in mathematics and science education. The active involvement of inservice educators from disadvantaged communities in this research would improve not only

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their research expertise, but could also be used to improve their academic qualifications. To this end, we are currently designing the first of a family of inter-disciplinary degrees, which will be presented jointly by the Department of Computer Science and the Faculty of Education.

The Future and the Plan

We have applied for substantial funding for the plan from a major South African research _ supporting organization and hope to hear the results of our application in January of 1994. The degree to which the plan can be realized in practice will depend on a number of factors, one of which is the amount of funds that become available. But we are hopeful and positive, and we intend educational enhancement for both students and teachers to be an essential part of our outreach programme in the future.

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Integrating Technology And Academics: Uncovering Staff Development Needs

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This paper will summarize issues that have implications for teacher education and staff development. The research and demonstration project was called Learning To Learn Through Technology (LTL Project). It provided an opportunity in two schools for selected students and teachers to be involved in a project that introduced computer-based, multimedia technology. It was hoped that the technology would promote independent problem-solving and more meaningful learning among students. It was predicted that students and teachers, when supported by training and a trellis of sophisticated technology, could become more self-regulated and more quality-conscious learners. Students were to design and develop projects and exhibitions that would show their reasoning and problem-solving skills in the form of multimedia presentations.

The students who were enrolled for one semester in a required, core course (science, social science, mathematics or language arts) were also enrolled in an "Independent Project" course in place of or as part of a scheduled elective course. It was anticipated that this scenario would contribute to each school's overall understanding of restructuring and its implications for day-to-day operations.

Teacher education and staff development needs

Teacher education and staff development needs will be framed in terms of three primary categories of need: (a) knowledge about technology—technological literacy; (b) ability to work with other teachers as a team—cooperation and collaboration; and (c) ability to focus on learning when working with students—learning-centeredness. Essentially, the behavior of the involved adults and youngsters revealed the way people in schools perceive their respective roles relative to one or more of three key components of an instructional program. The key components of schooling used to specify role behavior were: (a) operations and management, (b) classroom instruction, and (c) the formal curriculum.

The purpose of the LTL Project

The purpose was to promote problem-solving and meaningful learning for students in a technologically-determined framework that allows students to learn to operate as self-regulated and risk-taking learners.

Implementation Guidelines and Commitments

Planning, Support and Conduct of Student Projects

Students, as part of an independent-study course, guided by a core-subject (required academic course) teacher and a site coordinator/teacher, were asked to identify a local phenomenon that has been affected or is being affected by the changing social and physical environment (Nachtigal et al., 1988). These students would plan and conduct an experiment or investigation related to the phenomenon and report their conclusions using high quality, computer-based, multimedia technology. Students' conclusions, expressed in multimedia presentations supported by well reasoned arguments, would be given before a panel of local community members.

Learning environment, participation, and access to workstations

Students were expected to participate in the project for 18 weeks (one semester). With the consent of the core-course teacher, participating students were to be excused from regular attendance in the required, core course to work on their "independent" research projects — effectively giving students up to two hours to work on their project on days approved by their core teachers. It was agreed that pairs or small groups of students would work together when at all possible, especially when enrolled in the same required, core course.

The multimedia work stations, provided by McREL, were to be made available for use by small teams of students as much as possible throughout the school day. The research sites were asked to create a learning environment where real-world events, objects and situations are examined using real-world tools, materials, and technology to produce quality exhibitions/presentations. (Parker, 1991; Wiggins, 1989; Resnick, 1989; SCANS Report, 1991; Marzano, et al., 1992). In addition, in an effort to ensure a focus on learning and the learner, sites were asked to create situations that would help youngsters become independent, self-regulated learners (McCombs, 1992).

Technical assistance, evaluation, and hardware and software maintenance

McREL provided two multimedia work stations for each site for one semester. Each work station included: a Macintosh IIci with 20 MB of RAM, a 120 MB hard drive, an in/out video card, an audio recording device and a S-VHS VCR. Other equipment "shared" at the two work stations included: a CD-ROM player, a scanner, a laser-disk player, a removable cartridge drive, and a color monitor. Each work station was supplied with a broad range of multimedia and presentation software. In addition, students were provided with 2 S-VHS camcorders, lighting equipment, microphones and a modem (sites were asked to provide a dedicated line for the modem). The site school districts agreed to maintain the equipment in a safe place and insure it as if it were their own, and return it to McREL in good condition at the end of the LTL Project.

McREL agreed to provide project design support and technical training for the site coordinator/teachers and two students from each site. The basic technical assistance and training on the hardware and software was provided by an experienced teacher and multimedia software developer. The technical assistance and training included an initial design and training session for four days the summer preceding the beginning of the project at the first site, and three days at the end of the first semester of the project, and technical assistance at anytime by phone during the project.

The LTL Project evaluation was based on the final projects/exhibitions developed by the students, student and teacher journals, interviews and observations conducted by the McREL coordinators, and a survey administered on a pre-post basis. The survey consisted of a set of subscales taken from previously-developed instruments, and was designed to measure motivation, self-regulation, academic engagement and interest.

Observations and Comments

Planning, supervision, support and conduct of student projects

Neither site could fully accommodate these guidelines and commitments. Support and assistance from core-course teachers was weak at best, and the management and operations of the schools were virtually inflexible. What success students and teachers experienced resulted from their personal commitment of time and energy. This is especially true in the case of Victoria where a strong work ethic seems to operate.

In Victoria, even with the coordinator/teacher's dedicated and conscientious work, only one "core" teacher (a social studies teacher whose son was involved in the project) could be recruited to assist with the planning and development of student projects. Later, the school counselor and the librarian agreed to assist with another of the initial five projects students had decided to pursue. These two multimedia projects were the only student projects completed at either site during the LTL Project. Even though the participation by the collaborating teachers at Victoria was limited — the social studies teacher providing the most assistance by helping students identify resources and agreeing to be interviewed on camera for a *QuickTime*™ movie — it seems to have been critical in determining if a student project was to be successful or not.

In Vandyke, students who enrolled in a combination speech/geography course were initially taking part in the LTL Project. However, their teacher, who was also one of the two LTL Project coordinator/teachers and the only "core" teacher willing to assist, withdrew from the project at the end of nine weeks taking his core-course students with him. This left the entire LTL Project in the hands of the remaining LTL Project coordinator/teacher with no assistance from any professional staff members. None of the five student projects begun at the Vandyke site were completed.

Neither site allowed much additional time for the coordinator/teachers to facilitate and mediate the LTL Project in their schools. In retrospect, it probably would have been helpful if a stipend or substitute pay, equivalent to 1/8-time, had been built into the project plan. This might have given more flexibility to the involved teachers and their administrators.

Learning environment, participation, research and access to workstations

At the Victoria site, the equipment was set up in the classroom of the coordinator/teacher who was also a business and computing teacher. This made accessibility a problem, because the classroom was in use for scheduled classes most of the day. However, this had little impact on the outcomes of the LTL Project because students were not released from their core-courses to work on their independent projects.

By her own admission, the site coordinator/teacher in Victoria, struggled with the issue of how to provide the authentic, learning-centered environment. She found it hard to keep from directing the process through the small, sequential steps she had traditionally used in her business computing courses. With some help from the school's counselor and librarian and by changing her expectations she was able to give her students a great deal more responsibility for their own learning. She became an enthusiastic supporter of her students' independent learning efforts. When asked what she would tell others who are interested in teaching a "project-type" class, she replied:

I would tell them that you have to come away from just being the traditional teacher...(you can't) come in each day and expect the kids to be on task...you have to let them (the kids) take a lot more responsibility...you have to be really flexible and be willing to work differently with different kids in the same group.

In contrast, in Vandyke no one took responsibility for seeing that the workstations were available in any meaningful way until midway through the semester. At that point one of the coordinator/teachers dropped out of the project and so, by default, the equipment was moved to the vocational agriculture (vo-ag) building, just behind the school. Until that time the equipment had been in the library, "on display." When researchers arrived for their first site visit, the workstations were set up in the library, visible from most vantage points, with a big banner hung above them that read, "The McREL Learning to Learn Through Technology Project." Students were invited to stop by and "experiment" with the hardware and software with little or no guidance or supervision. When the equipment was moved to the vo-ag building, distancing it from most of the classrooms by hundreds of feet, access was difficult for many students. The location of the equipment went from a totally open-access situation to a limited-access situation. Six weeks into the 18 week period, no student-project topics had been confirmed, except for the projects selected by the students who had attended the pre-project training sessions. In terms of creating a learner-centered environment, other than the initial freedom to explore the equipment in the library, there did not seem to be any real efforts by the adults in the school to do anything differently.

Technical assistance, evaluation, and hardware and software maintenance

The design and training sessions were attended by the multimedia specialist/trainer, the McREL project coordinators, and the site coordinators and at least two students from each site. The work sessions seemed to go well, with the youngsters quickly becoming the "top students in the class." At the end of the first design/training session the participants from the sites reported that they were quite enthusiastic about the potential of the project, but were split on where they thought they would have difficulty. The adults generally thought that they needed more work with the equipment and software. The students, while they were not overly confident about using the technology, felt they would have more difficulty explaining the purpose of the project to others than they would in mastering the technology.

The second design/training session was attended by two additional teachers and two additional students from Vandyke. It turned out to be a "trouble shooting" session, with the project technical specialist spending a great deal of time assisting students from Victoria as they put the finishing touches on the two projects they completed.

As the LTL Project unfolded at Victoria the McREL researchers realized that the support from core teachers and administrators was not nearly as strong as they had hoped. Determined to increase the level of on-site support at Vandyke, McREL's researchers arranged to meet with the faculty and administration in early December. At this meeting they hoped to raise the level of awareness and to appeal for participation. In another attempt to ensure that the project was truly a demonstration, McREL's researchers arranged for two additional training sessions in Vandyke. One of the additional training sessions was conducted about four weeks into the project by two teachers who had, for the past three years, successfully used a multimedia-project approach in their classes. Approximately 75% of the school's teachers and student population participated in a demonstration portion of the session, which was well organized. But, the work-session portion, reserved for the LTL Project participants, was poorly organized and poorly attended — no special schedule releasing the site coordinator/teachers and the students was arranged. The second, additional training session conducted at Vandyke was poorly attended, even though the session had been scheduled for several weeks.

Both Victoria and Vandyke took good care of the equipment. No equipment was damaged, lost or seriously misused during the LTL Project. At Victoria, the site coordinator/teacher integrated the workstations with the network of computers in her lab when feasible and when software licensing permitted. Both schools arranged the equipment in configurations that seemed to facilitate effective use of all of the work-station peripherals. However, in terms of supervision and mediation of the skillful use of the technology, Victoria, where the LTL Project had been centered in a regularly scheduled elective course, provided a near optimal situation. In Vandyke, where the LTL Project seemed to "float," not anchored to any regularly scheduled class, minor misuse of the equipment—e.g., excessive game playing—was reported and observed.

While the configurations of the work stations seemed to be effective at both sites, there is some question in the minds of the researchers as to the actual, useful operation of the equipment. For example, it was at least six weeks into the project at the first site, Victoria, before the McREL coordinators were told that the color monitor did not work—it had been severely damaged during assembly or shipping. And, it was not until the second design/training session in January that it was discovered that one of the VCRs was not working properly. In Vandyke, six weeks into the semester, the site coordinator revealed that he could not get the CD-ROM player to operate properly. One of the work station video in/out cards, later to be found to work perfectly, was never successfully used by participants at either site.

Recommendations

All of the primary components of schooling — operations and management, classroom instruction and the formal curriculum—are inextricably connected and interrelated. If people are to succeed in making changes in any one of the primary components, there will have to be adjustments made in the other two. Therefore, the comments that follow, which have been organized by components, can not be read as if they apply to only one element.

Operations and Management Recommendations

In light of the structural rigidity demonstrated at both sites in terms of scheduling and academic flexibility, teachers desperately need education and training in the philosophical and political nature of schools and the related skills needed to become advocates for the changes they believe in. To prepare them solely for positions in the social technology of the industrial era, for institutions fashioned after the factory model, is to do them a disservice. Even though there were people in Victoria and Vandyke that believed the goals of the LTL Project were important in the educative process, there was no evidence in Victoria or Vandyke that teachers and administrators had thought critically about what it meant to restructure for the purpose of implementing those goals.

Instructional Program Recommendations

Perhaps the most glaring need that surfaced during the LTL Project concerns the apparent difficulty in collaborating across subject matter or discipline lines. Our assumption that technology would be a "natural" way to demonstrate collaboration and integration of conceptual and procedural knowledge at the two sites was misguided. The lack of interest in integrating technology shown by core, academic teachers was surprising, and leads to the next identified need: more comprehensive technological literacy among teachers. In both Victoria and Vandyke the level of knowledge regarding technology seemed extremely low, even among vocational and business teachers. As Seymour Papert (1993) has recently noted regarding the general level of knowledge teachers have of technology, "Someone who had so minimal a level of knowledge of reading, writing, and literature would be called illiterate...." Those who have promoted minimal literacy in technology for the past decade or so, and who have been the most influential in teacher education, have not fully understood how important and powerful technological mediums have become (Ellul, 1990; Postman, 1992). Educators must expand their definition of technological literacy. Technology has become more than a "tool" to be picked up and used when one decides it is needed; it has become a medium that mediates experience in most walks of life. The consequences of technology, both positive and negative, affect each of us more and more each day. It must have a more prominent place in the instructional process if youngsters are to become critical stewards, users and developers of technology. That means technology must be integrated throughout the instructional program of preservice and inservice teachers.

Curriculum Recommendations

The poor neglected step-sisters in the family of curriculum content have been technical and procedural knowledge. Teacher education programs and staff development efforts will have to address this issue creatively. Subject matter by itself does not address the issue of how we make knowledge useful, but once people have a use for an idea or object, a purpose, then technical and procedural knowledge can make things happen. This means that purpose must be built into our curriculum. As the teacher and students of Victoria realized, when they had a clear purpose for using the technology learning how to use it was relatively easy; and when they realized that doing a quality project was possible and important the subject matter was more easily mastered.

The connection among technical, procedural, and conceptual knowledge is innate. We in education have for too long spent a great deal of energy obscuring that connection. The purposeful use of knowledge is the essence of technology, thus technology is the business of all disciplines and our teacher education curriculum should reflect the importance of that essence.

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Technology's Role in Restructuring: A Teacher Preparation Program

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One of the critical issues facing teacher educators today is how to restructure teacher preparation programs to meet future technological needs of students in the nation's public school system. One promising solution is to restructure teacher education programs through the infusion of technology and, at the same time, to prepare all teachers to use new technology in their classrooms. The Texas Education Agency (TEA) has provided the avenue in Texas for this restructuring to take place through a model of professional school and community partnerships linking colleges of education, schools, and the business community. In *Restructuring the Education of Teachers for the 21st Century* (1991) the Association of Teacher Educators makes it clear that partnerships among the individuals and the organizations with stakes in teacher education are key to effectively restructuring and improving education.

The 72nd Texas Legislature dedicated 10 million dollars which assisted the TEA to take a leadership role in the restructuring process. TEA has established thirteen Texas Centers for Professional Development and Technology to restructure teacher education in Texas. While these center's programs are quite diverse, they share a commitment to collaboratively providing field-based teacher preservice education, staff development, and teaching and learning opportunities using state-of-the-art technology. The expected outcomes of each center's initiative will be successful students, life-long learners, and the integration of technology (Texas Education Agency, 1993).

Center for Educational Development and Excellence (CEDE)

Our Lady of the Lake University is directly involved as a collaborative partner in the San Antonio based Center for Educational Development and Excellence (CEDE), one of the eight original centers established in 1991. CEDE's mission is "to be a collaborative community, a center of inquiry dedicated to continuous lifelong development of teachers as learners in a culturally diverse, technology enriched, educational environment " (San Antonio Center for Educational Development and Excellence, 1992). This center is unique in that it involves one public university, four private universities, and one community college: The University of Texas at San Antonio, Trinity University, Incarnate Word College, Our Lady of the Lake University, St. Mary's University, and San Antonio Community College. Six area school districts are also involved as partners of CEDE. Region 20 Educational Service Center and a variety of community institutions in San Antonio completes the partnership of CEDE.

This unique partnership has collaboratively developed a new vision for teacher education focusing on technology-based instructional techniques to inspire teachers in the field as well as preservice teachers to become life-long learners. While there are many aspects of CEDE, the technological component is a major focus. CEDE's technology goals include developing the technical competence of members of the collaborative and teacher education students to use technology in everyday instruction, increasing the access to new instructional technology for members of the group increasing the degree to which technology is an integral part of instruction in teacher education programs and the school classrooms of San Antonio and South Central Texas. Helping teachers to use, understand, and employ technology in their work permeates CEDE's technology infrastructure (San Antonio Center for Educational Development and Excellence, 1992).

The technology classroom

As a part of CEDE, Our Lady of the Lake University has chosen to establish a state-of-the-art technology classroom at one of its Professional Development Schools to train its preservice teachers, university faculty, teachers and students at the Professional Development Schools. Davis (1993) states that "professional development is necessary for everyone in education to keep them up to date and to refresh their approach." Working from this premise, the technology classroom was established, creating educational opportunities for faculty to become proficient with technology and develop ways for the technology to permeate their coursework. Preservice teachers and classroom teachers will also have opportunities for professional development in technology use. Berliner (1988) maintains that continued professional development must be sustained for teachers to develop proficiency. Through the technology classroom, a new vision of instruction in classrooms is emerging for our faculty and partners.

The technology classroom is dedicated to the infusion of technology into all learning environments. At the center of the technology classroom is a computer lab with both Macintosh and DOS-based computers. This allows us to meet the diverse application needs found in schools. To maximize the use of the hardware and to meet users needs an extensive range of software has been purchased. In addition, a cutting edge multimedia production and demonstration center and fax center are a part of the technology classroom. Telecommunications, distance learning, and video conferencing opportunities are also available. To support these efforts the university has employed a part-time technology coordinator to oversee the training in the technology classroom. Region 20 Service Center is also providing training through CEDE for trainers of teachers selected from mentor teachers at the Professional Development Schools.

Conclusion

Training is critical to the success of our efforts to integrate technology into teaching. The delivery of new technology in the technology classroom is taking many forms—from formal courses on instructional media to workshops and individual modules on technology. Through the technology classroom, Our Lady of the Lake University hopes to establish new learning environments which will reflect both state-of-the-art technology and state-of-the-art in educational practice.

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Train the Trainer: A Model for Faculty Development

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This paper describes an innovative model for faculty development with instructional technology at the university level. The *Train the Trainer* model is currently being used by the School of Education and Human Development at California State University, Fresno to prepare its faculty to make optimal use of new state-of-the-art educational facility . The purpose of *Train the Trainer* is to facilitate the use of instructional technology through the formation and development of a core cadre of faculty members who are dedicated to using technology in teacher education.

Inservice training with technology has been lacking in higher education. While some faculty are making innovative and effective use of emerging technologies, the majority continue to teach the way they were taught 10, 20, or even 30 years ago. In many colleges and universities, the lecture remains the predominate method for delivering instruction. The majority of university teachers appear to be unwilling or unable to incorporate instructional technologies into their classrooms. The great potential of technology has not been harnessed by faculty on most college campuses. McNeil (1989) writes that technology has "not even come close to making a difference in the lives and learning experiences of most Americans (p. A44)." For technology to make a difference in higher education, faculty must be made aware of the power and potential of technology and must receive training in the effective use of the many applications of technology.

Overview

The need to make greater and more effective use of technology in the classroom is present at every college and university in the United States. In order to meet this goal, there is a profound need for faculty development with technology. The need for faculty development is even more pressing at California State University, Fresno because the faculty of the School of Education and Human Development will move into a new building in the Spring of 1994. The new building was designed and equipped to harness the potential power of instructional technology and to use that power to improve the quality of teacher education.

The five story, 115,000 square foot facility will be a state-of the art building for teacher education. The new building will have computer classrooms and self-study computer laboratories, a comprehensive technology center, demonstration classrooms, teaching and clinical laboratories, microteaching laboratories, a video production studio, and technical support area. These spaces are integrated into a comprehensive optical fiber, coaxial and twisted pair network linked to the campus voice, data, and video communication system All designated spaces in the building will have the capability of transmitting and receiving programs from remote sites. A teleclassroom and two video conference rooms will be dedicated to the delivery of distance learning programs to off-campus sites. In an effort to prepare the faculty to make optimal use of the advanced technology available in the new building, inservice training with technology had to begin early.

California State University, Fresno selected *Train the Trainer* as the best model for conducting faculty develop-

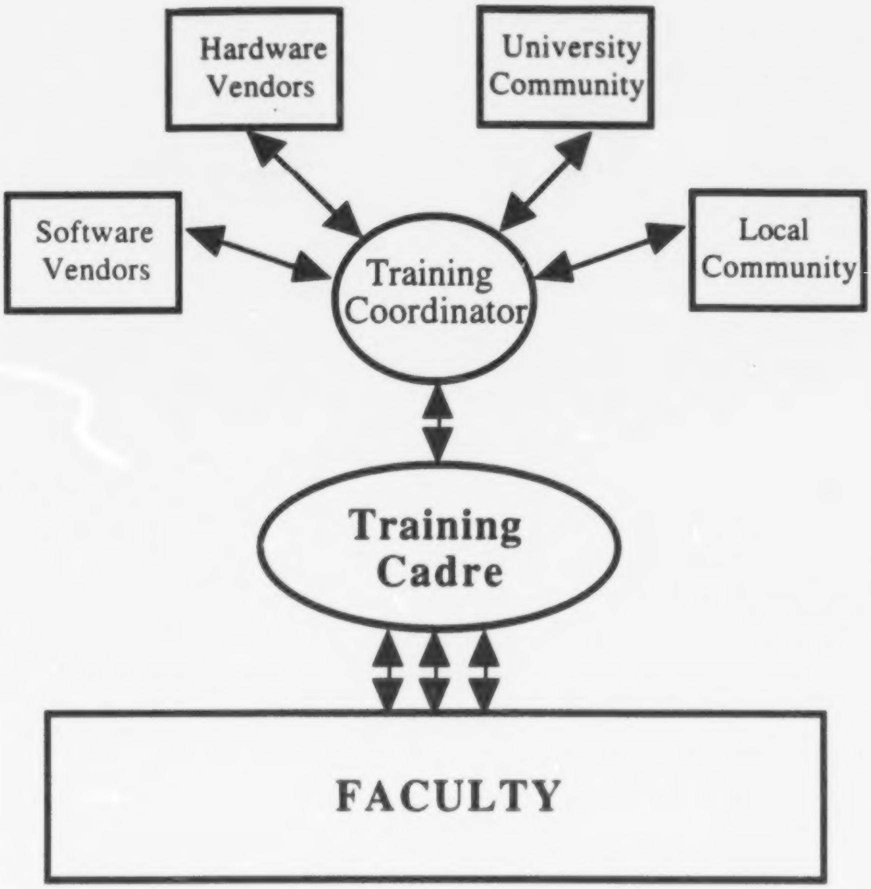

Figure 1. A graphic representation of the *Train the Trainer* model.

ment with technology. The model (see Figure 1) calls for the selection of a training coordinator and the development of a small cadre of faculty members who will become the trainers. This cadre receives training on a variety of hardware and software platforms from either the training coordinator or from people outside the university. The training cadre then conducts training for the rest of the faculty. The roles of the training coordinator and the training faculty are discussed in greater detail in the following sections of this paper. Also discussed are strategies for training faculty and the long-term goals of the *Train the Trainer* model at CSU, Fresno.

The Training Coordinator

The Training Coordinator (TC) is the most important person in the *Train the Trainer* model. The TC is responsible for instituting the *Train the Trainer* model, assembling the training cadre, conducting or arranging training sessions, and scheduling formal training sessions for the entire faculty. The TC also serves as a liaison between the faculty, the university, and off-campus resources such as software and hardware vendors.

The Training Coordinator's first responsibility is to assemble the faculty who will become the training cadre. The TC must be aware of the skills and experiences of the faculty in order to identify and recruit an informed and representative cadre. As a result, the TC at most universities will come from a central location such as a Dean's office or instructional media center. At CSU, Fresno, the Director of the School of Education's Instructional Technology & Resource Center serves as the Training Coordinator.

The number of training cadre members will differ from situation to situation. At CSU, Fresno, there are 10 members of the cadre and approximately 100 faculty and staff members. This ratio of 1 to 10 appears to be an efficient one. When selecting training cadre members, it is important to create a cadre that is representative of the school's overall faculty. For example, if 75% of the faculty use Macintosh computers, it would be important for most of the training cadre to be Macintosh users. The TC may also want to consider other factors such as academic discipline, academic departments, age, or gender when selecting the cadre. The theory behind this attention to diversity is that a cadre that closely represents the overall faculty demographics will be more effective in serving as role models with technology.

Another important part of the Training Coordinator's job is to serve as a liaison between the faculty and hardware and software vendors. The TC should contact vendors and work with them to provide demonstration materials and to train the training cadre. Many vendors will provide free training or training materials if doing so will result in added exposure to their products.

The training cadre

To begin the process of inservice training at CSU, Fresno, a cadre of 10 faculty members was formed. Each received training on a variety of computer applications. Partnerships were formed with several corporations who agreed to supply advanced software and training. Software partnerships were formed with MECC, Aldus Corporation and Humanities Software, among many others. The plan is for all cadre faculty to receive training in all of the advanced applications and to incorporate selected applications into their classroom teaching.

An important aspect of *Train the Trainer* is dividing the training duties among the cadre members. Under the model, there is a division of labor and no one cadre member is responsible for too much of the training workload. All of the cadre members receive training in all of the applications. However, after receiving training on all the applications, each member of the training cadre selects one or more of the applications and serves as a trainer for only those applications to the entire faculty. For example, a cadre member might develop a particular interest in a word processing application. That cadre member would then hold workshops and demonstrations for other interested faculty members on that application.

The training faculty members serve as role models as well as trainers. The cadre members are expected to incorporate the applications they use the most into their classrooms. They are encouraged to develop ways that the applications can be used to create new and innovative classroom experiences for their students. Other faculty members can observe the innovative applications and make suggestions or modifications based on their own experiences and needs.

Developing incentives for participation is an important issue when organizing the training cadre. University faculty are very busy people. Even those faculty who advocate the increased use of technology in the classroom often find it difficult to devote the time and effort necessary to train others in the use of technology. As a result, powerful, tangible incentives must be in place to attract faculty into the training cadre. As fiscal and political situations differ from school to school, each university must develop incentives that are powerful and tangible to their particular faculty. At CSU, Fresno, members of the training cadre were given new computers for their office use as an incentive. The promise of a new computer in a time of deep fiscal difficulties and aging workstations proved to be an effective incentive.

Training the faculty

Following training, each cadre member conducted training for non-cadre faculty. The training was both formal and informal, involving the use of workshops and one-to-one discussions. The advantage of this faculty-to-faculty training technique is that it allows non-cadre faculty members to learn about technology in a nonthreatening, collegial atmosphere. It is expected that 30% of the School of Education and Human Development faculty will receive training on at least one advanced application of technology by the end of *Train the Trainer's* first year. Ultimately, it is expected that all of the faculty and staff will receive training on at least one application. It is also expected that trainers will provide training and serve as technology role models to teachers in the local K-12 school district. Workshops for school teachers and administrators will be offered at night or on weekends.

The first step in training the entire faculty in the use of technology is to raise the faculty's awareness of technology's power and potential. Many faculty don't know what types of technology exist nor how to use them in their classrooms. Awareness of these issues can be raised through a series of demonstrations and workshops. Demonstrations can be to introduce faculty members to a wide variety of software or to show-off an innovative application of technology in the classroom. Workshops are useful in teaching faculty how to use and work with a certain technology.

In addition to conducting formal demonstrations and workshops, the training cadre will also serve as informal technology resources for the faculty. The names of the training cadre and the applications they specialize in are circulated to the entire faculty. Faculty members then know which cadre members to contact when they have a question about a particular application. This informal, one-to-one training is a necessary and important component of the model.

Long term goals

The long terms goals of the *Train the Trainer* model at CSU, Fresno are to offer continued training on new technologies as they emerge and to foster innovative applications of technology in the classroom. One advantage of the model is that, once established, the infrastructure can be used for a long period of time. As faculty become skilled in applications, the training cadre can learn newer applications and, in turn, provide training on emerging technologies to the entire faculty. One factor to consider with long-term implementation is the need to provide ongoing incentives for the trainers. A new computer may be sufficient to recruit a faculty member to become a trainer, but it is not sufficient to justify three, four, or five years worth of extra work.

Another advantage of the *Train the Trainer* model is that it provides opportunities for faculty and students to observe the benefits of technology in actual practice. The cadre members use technology to model best teaching practices and the advantages of technology to their students and fellow faculty. According to a theory developed by Rogers (1983), if the benefits and advantages of an innovation are observable, the innovation is more likely to be adopted and diffused throughout a social system. *Train the Trainer* makes the benefits of technology observable and, as a result, increases the likelihood that other educators will adopt and use the technology.

Summary

Technology is slowly becoming more and more pervasive in higher education. In coming years, university faculty will have access to a great array of instructional and information technology. If selected and used properly, these new technologies can have a profound, positive impact on teaching in higher education. However, faculty must receive training in order to maximize the impact of these technologies. *Train the Trainer* is a model of faculty development that emphasizes cooperative and ongoing training. Through the development of a small cadre of faculty members, the skills necessary to use technology are diffused throughout the entire faculty. The purpose of this model is to foster a climate of instructional innovation through technology. The ultimate goal of the model is to create a dynamic, imaginative School of Education in which every faculty member is a trainer, mentor, and leader in the use of instructional technology.

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Computers And Crayons: Training Teachers In Developmentally Appropriate Computer Use

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As computer literacy becomes a more fundamental skill for achieving personal and business success, schools are making increased efforts to prepare students for entry into the twenty-first century through computer technology. Software Publishers' Association (1993) reported that US schools spent a total of $2.1 billion on computer technology in the 1992-93 school year, and this figure is expected to rise 20% in the next year. It has been estimated that up to 98% of public schools now own at least one computer (The Computer Report Card, 1989). Figures such as these suggest that the computer has successfully assumed its role in elementary education. However, the mere presence of computers does not ensure their implementation into the curriculum.

Half of all K-12 teachers with access to computers report never having used them in instruction (Fulton, 1989). One contributor to this technological idleness is the absence of proper computer training in traditional teacher preparation programs. Only twenty-seven states require any type of computer training for teacher certification (Hess, 1992), and in most cases this requirement can be satisfied through a basic introduction to computers course that does not address the implementation of computers into the curriculum or the needs of the young child (Fulton, 1989). Often, machines sit idle in the corner of the elementary classroom, or are relegated to a distant lab which students visit infrequently, if ever. If computer technology is to realize its full potential as a powerful instructional tool, teachers must be convinced of the value of this technology and be provided the training needed to use computers as an integrated part of the curriculum.

For the past ten years, the Technology in Early Childhood Habitats (TECH) program at the University of Delaware has provided training for preservice and inservice teachers in the use of computer technology with young children. The model of instruction developed for this program emphasizes the use of the computer as a developmentally appropriate tool for use in an early childhood curriculum. Rooted in current research and theory, this model consists of three fundamental elements: theoretical foundation, hands-on practice, and constructive evaluation. In a practicum experience, teachers interact with children in a functioning classroom, work under the guidance of a mentoring teacher, and gradually assume the role of instructor in the computer-integrated classroom.

This paper describes both the model of instruction implemented by TECH to train teachers to use technology with young children, and the course content. Through survey data collected from course participants, we will conclude by examining strengths and weaknesses of this model, and future directions of technology instruction in teacher education.

What is TECH?

The Technology in Early Childhood Habitats (TECH) program was originally begun in 1983 as an extension of the University of Delaware's Laboratory Preschool. In the early eighties, computers were springing up in day cares and kindergartens and being touted as the greatest boon to education since the chalkboard. TECH was organized in response to this social and educational phenomenon, with several objectives in mind. First, the computer needed to be studied to determine if young children could use one. If so, an appropriate computer-enriched curriculum needed to be developed, and a resource established where pre- and inservice teachers could receive necessary training. It is this last piece, that of professional training, which is the focus of this paper.

Goals and Objectives

The guiding purpose of training by TECH is to produce teachers who are capable of and confident in the use of technology as an integral component of their early childhood program. The philosophy guiding this effort is that effective instruction of young children conforms to the standards of developmentally appropriate practice as defined by the National Association for the Education of Young Children (NAEYC) (Bredekamp, 1987). It is one thing for teachers to become familiar with technology and another for them to be trained to use technology across the curriculum in developmentally appropriate ways. A computer in the classroom is often used primarily for reward and remediation. Knowing how to use the computer to maximize children's development in appropriate ways, however, is what is needed.

The audience served by this project has consisted primarily of preservice and inservice teachers who work with young children in preschool, kindergarten, or day-care settings. Teacher participants of lower and middle elementary school grades have also found this training highly relevant. In the past five years alone, TECH has trained approximately 100 teachers locally and from across the country.

The Teacher Training Process

Offered as a regular University of Delaware course at both the undergraduate and graduate level, as well as a Continuing Education Institute, this training has traditionally been conducted during a five-week summer session. Held in the University of Delaware's Laboratory Preschool the participants have had access to all the materials of the Lab School, as well as the substantial TECH software collection and state-of-the-art hardware including numerous color printers, scanners, and video technologies. One unique feature of the TECH summer training is its ability to offer experience with open-ended and exploration software that is not commonly found in early childhood classrooms. As an independent educational organization, TECH has the opportunity to evaluate hundreds of software programs and select the best programs for use in the early childhood curriculum.

The Intensive Week

The professional instruction program begins with an intensive five-day, thirty-five hour training period. In accordance with the characteristics of effective training programs as outlined by Epstein (1993), the participants' initial exposure to TECH consists of a complementary balance of theory and practice. Approximately half of each day's schedule is devoted to direct instruction of the theoretical basis for appropriate computer use with young children; the remaining time is given to daily hands-on computer exploration, concentrated technical training, and software evaluation. All of these elements are then applied and evaluated during the practicum period.

Theoretical Foundation

Before teachers can effectively utilize the computer as a developmentally appropriate educational tool, they must understand why this technology is suitable for use with young children. During the intensive week, the instructor presents the teachers with a concentrated view of developmental theory, including the related work of Bruner, Erikson, Papert, Piaget, Vygotsky and Social Competence Theory. For example, in accordance with Papert's version of Piagetian theory, Logo-like software can be developed to present microworlds, places in which children have the freedom and security to explore situations to which they may otherwise have no access. Piaget often referred to children's cognitive structures as 'microviews' of the world.

Becoming familiar with the relationship between developmental theory and technology allows the participants to more effectively implement the computer as an appropriate instructional tool within their existing paradigms of teaching. Teachers can then design activities that take advantage of this technology's potential to enhance children's natural development, for example, by providing children with a piece of "microworld" software that encourages exploration in the same way that the block corner or clay table encourages experimentation with a particular set of concepts.

In addition to developmental theory, the course addresses many of the myths that have been propagated which oppose computer use with children, and subsequently refutes these arguments with current research. For the past ten years there has been considerable debate concerning the appropriateness of computers in early childhood education, and, though most of the arguments against the use of computers by young children have been laid to rest (Clements, 1987; Clements, Nastasi, & Swaminathan 1993; Shade & Watson, 1990; Watson, Nida, & Shade, 1986), some continue to resurface.

One such myth alleges that young children in the concrete operational stage are cognitively ill-equipped to comprehend the symbolic representation on a computer screen; as recent work demonstrates (Sheingold, 1986), much of what normally occurs in the early childhood classroom is symbolic. Furthermore, one could make the same criticism of picture books (Piestrup, 1985), which are certainly more static and less interactive than the majority of computer software. By addressing these issues, the course attempts to eradicate any prejudices the participants may harbor against computer use, thereby encouraging participants to include technology in their early childhood curriculum.

Technical Training

Because some of the participants come to this course without even the most fundamental computer experience of word-processing, the intensive week necessarily includes technological training. This hands-on training begins with the most basic procedures, such as how to turn the computer on and off, how to load various programs and navigate within them, and includes ample opportunity for independent exploration on the machines. For the teachers, then, this training progresses to such skills as installing programs on the hard drive and maintaining the hardware, duties that would be required of teachers who include computers in their classrooms. Before the end of the course, the participants are expected to complete a technical training checklist, which necessitates their facility with basic hardware operation and maintenance.

Software Evaluation

Just as teachers must make informed decisions about the literature included in the classroom library, so must they be able to recognize high-quality software for use in their curriculum. Training is provided during this time for teachers to become familiar with the characteristics of developmentally appropriate software (such as open-endedness, child-control, equitable gender and multicultural representation, etc.), and to rate the programs according to the Developmental Software Evaluation Scale (DSES) developed by Haugland and Shade (1988,1990). Many sample programs, demonstrating a high- and low-score piece for each characteristic, are viewed during the discussion of the features. Teachers are encouraged to explore TECH's extensive software library, and to evaluate selected pieces using the DSES. This rating is done in pairs, again in the model of the children's usage, to foster discussion and cooperative efforts. The scores assigned by the participants are then compared to those given by expert evaluators, and the teachers are encouraged to justify any disparities in terms of how the program would be used with their own students. Additional software is introduced throughout the five weeks, until teachers have had the opportunity to examine approximately 100 to 130 of the best titles.

The Practicum

Because these participants are (or soon will be) teachers of children in functioning classrooms, the best way for them to gain confidence in using technology with children is to do it. The professional training, therefore, is conducted in concurrence with a four-week technology-enriched summer camp, sponsored by TECH, for children between the ages of four and seven. Teachers participate for a minimum of two days per week, though many choose to do more. From the first day, the teachers are directly involved with the children and the technology.

Observation Assignments

Throughout their placement in the camp, teachers are given the opportunity to observe children in their interactions with the computers and with their peers. These observations occur in the classroom, among the children. This attention to "kid-watching" provides genuine illustrations of the theory the teachers have studied, so that they may recognize how children actually respond to the computer-enriched environment. In addition, the participants have the chance to observe the methods and activities used by the program's lead teacher, as a model of appropriate practice, as well as the selection of material used and room setup.

Interaction With Children

Because these participants have been trained in pedagogy and educational theory, often the most effective way for them to learn a topic is to teach it. From the beginning of their placement, teachers are expected to instruct the children in use of the hardware and software. In order to scaffold the teachers into their new responsibilities, TECH allows participants to teach a "recipe" lesson, that is, one that has been lifted directly out of the resource file of lessons taught in previous years. This plan may involve the introduction of a piece of software, instruction in basic features of the hardware (such as how to load a disk), or other fundamental concepts required for computer use (selecting from a menu, etc.). Implemented in the first day or two of the camp, this lesson offers the teachers a low-risk opportunity to become familiar with appropriate instructional techniques in the computer-integrated classroom, and to gain expertise with various features of the computer.

Integration Of Computers Across The Curriculum

In addition to the "recipe" plan, the teachers are expected to design and implement three original lessons that complement the curriculum of the camp. These lessons should support a variety of computer related skills and concepts, and should be aimed at including these skills in various areas of the classroom, such as art, literacy, dramatic play, math/science, health/nutrition, problem solving, and physical development. In designing these plans, teachers select a small number of software titles on which they become "experts," and which they are able to teach to the students through appropriate methods. Upon approval by the cooperating teacher, these lessons are taught by the teachers as part of the regular camp curriculum, in accordance with the project's philosophy that technology can be utilized as an integral component of the early childhood classroom.

Teacher Evaluation

Throughout this course, opportunities are available for constructive, immediate feedback to the teachers. After each lesson is implemented, a self-evaluation is completed by the participant, and then discussed with the instructor. The instructor also makes a formal observation and offers evaluation of one lesson conducted by each participant. In addition, the cooperating teacher observes each activity, completes a brief evaluation of the lesson, and offers constructive feedback which can be directly applied to the next lesson plan. A final evaluation, completed in conference with the cooperating teacher, highlights the strengths of each participant's experience, and offers general suggestions for the teacher's future integration of computers in the classroom.

Program Effectiveness

In order to informally assess the effectiveness of the TECH training course, we conducted a nonrandom telephone survey of former students. The purpose of the survey was twofold: to elicit feedback on the usefulness and strengths of the course, and to assess the current status of computer use in the classrooms of the participants.

Asked to rate the training on the extent to which it affected their performance in a number of areas (i.e. the ability to recognize quality software, to integrate computers into the curriculum, to use computers with children, and to feel personally confident with the software and hardware), the responding teachers reported a high degree of satisfaction with the course, giving the class a mean score of 4.4 out of 5 for general usefulness. Most highly rated of the individual areas, with a mean score of 4.9, was the teachers' perceived ability to recognize and select quality software for their classrooms. Teachers also responded positively to the course's success in teaching them to incorporate computers into the curriculum and to comfortably use technology with children, which received average scores of 4.6 and 4.3, respectively.

Almost all of the responding teachers currently have at least one computer in the classroom, which is available for the children's use every day. Many of the preschool and kindergarten teachers explained that they have established the computer as one of their "centers," that is, the computer was one of many activities a child could choose from during free play.

We found that where teachers were involved in selecting software for their own classrooms, the quality of the software was typically outstanding, representing appropriate and open-ended programs rather than more drill and practice oriented software. However, when teachers were not involved in the selection process, they expressed a degree of dissatisfaction and frustration with available materials. Interestingly, the teachers who were involved in the TECH training seemed to have been better prepared to select developmentally appropriate software than the people whom the school or school board had appointed.

Perhaps most telling were the survey's open-ended questions, which asked the teachers to reflect on both the most useful aspects of the course and what they believed could have been improved. Teachers most commonly cited the opportunity to become familiar with a number of different software titles as the most positive aspect of the course. Next, participants lauded the course for increasing their self-confidence in evaluating and selecting developmentally appropriate software. In addition, teachers consistently mentioned their work with the children as one of the most powerful and effective aspects of their coursework, saying they enjoyed seeing how easily children interacted with appropriate software. Finally, teachers enjoyed seeing the possibilities and potentials of cutting-edge developments, such as CD-ROM, scanners, and powerful hard drives.

While there was broad consensus of participants' assessment of course strengths, their suggestions for improvement were more varied. The only repeated feedback was that the course was intense and fast-paced. However, it should be mentioned that when a course format which eliminated the most intense and rigorous portions was implemented, teachers reported feeling ill-prepared for their interaction with the children. Other comments reflected dissatisfaction with the short duration of the course, and the subsequently brief turnaround time between plan submission and lesson implementation. Participants would have appreciated having more time to spend with the lead teacher to plan lessons, as well as more exposure to software appropriate for older children. These suggestions will inform decisions concerning the planning of future training courses.

Future Directions

TECH is considering new directions for the future. As always, the program will offer the most recent, cutting-edge technology available; in the next year, the TECH plans to acquire additional hardware, a number of hand-held Newton computers, more CD-ROM titles, and new multimedia technologies. TECH will also be making efforts to extend its resources and training to a wider audience of teachers, many from other states Wherever the course is conducted, TECH will continue to produce teachers who are both knowledgeable and confident in the developmentally appropriate use of technology in the education of young children.

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The computer as an element that extends the intellectual human capacities has gone through fundamental changes since its appearance in the 40s. This change has also impacted the educational system where the study of the computers and their uses has become an important element. These rapid changes are not only of concern to educators. They have a special concern in being able to take advantage of the potential offered by computers and the ability to use it as an auxiliary aid for instructional.

This interest also developed in the Educational System of the Legionarios de Cristo. Computers have been acquired in different schools since the 1970s. School authorities noticed that, despite large investments in equipment, there was no evidence showing improvement of the educational process since the introduction of the computer. Because of this situation CICE was created in 1989. CICE is an investigation center with the main purpose of studying the computer and its use in education.

The objective of the OMEGA project is to design, produce and apply educational software to support the teaching of mathematics in elementary schools, helping with this the development of intellectual skills.

Design and Production of Educational Software

The following elements were considered prior to the development of the educational software .

Learning Outcomes

Learning environments can be organized around objectives that are related to five learning categories, each leading to different responses. For this reason, activities need different didactic conception to lead to effective learning. There are five different learning outcomes: Intellectual Skills, Cognitive Strategies, Verbal Information, Attitudes and Motor Skills.

Due to the objectives of the project, we decided to focus on intellectual skills. These skills enable the learner to do something that requires cognitive processing. There are three varieties of this skill.

1. ***Concept skills***:
   Concrete: Enables the learner to identify instances of an object, of an object property, of an event or of a spatial direction.
   Defined: The learner is able to demonstrate the application of a rule that defines the concept.
2. ***Rule:*** Is a cognitively understood relation between concepts.
3. ***Higher-order rules:*** where learners are able to encounter problems to be solved by the use of previously learned rules.

Intellectual development of the student

The next step was to determine the learner characteristics and the intellectual development of the children that would use the software we planned to develop. We considered the main phases of the cognitive development of the children established by Piaget during the development of this software.

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Didactic of the subject

When we began working in the project, we noticed that it is very common for mathematics to be presented in a mechanical way, where the results are important and the processes are less important. With this in mind, we tried to develop software where students are able to discover the new concepts and experiment with different situations where this concept may appear. We created feedback systems where students get a clue to the possible source of their error. The aim is to have the students learn from their own mistakes.

Internal learning Process	External Instructional Events	Examples of the Action
1. **Alerting** the learner to receive stimulation	1. Gaining attention	1. Using fast changes of stimulus
2. Acquiring an **expectansy** of the results of learning	2. Informing the learner of the lesson objectives	2. Telling the students what they will be able to do at the end
3. **Retrieval** of items in long term memory to the working memory	3. Stimulating recall or prior learning	3. Making the student remember the concepts and abilities previously learned
4. Selective perception of the patterns that enter into learning	4. Presenting the new stimuli or concept with distinctive features	4. Presenting the material emphasizing the principal characteristics.
5. Semantic encoding of presented material to attain a form for long-term storage and ready retrieval	5. Providing learning guidance.	5. Suggesting an organization that has a meaning
6. Responding with a performance that verifies learning	6. Eliciting performance	6. Asking the student to do certain activities.
7. Reinforcement, by means of which the results or learning are enabled	7. Providing feedback	7. Giving the student an informative feedback.
8. Providing cues that are are used in recall	8. Assessing Performance	8. Asking the student to continue doing exercises.
9. Generalizing performance to new situations	9. Enhancing retention and earning transfer	9. Guiding the student in practice and provide him with different exercises

Figure 1. Internal processes of learning, their functions, and the types of external events that may support them.

The Lessons

The lessons we have developed have the following main characteristics:

- The lessons are tutorials and are designed for elementary school students.
- The lessons are personalized. Students enter their name so the computer may address to them by that name.
- Short phrases are used. We don't saturate the screens with text because we believe this makes the lessons less attractive for the students.
- Key elements are placed in the center of the screen. Due to the age of the students, where distraction is inevitable, we place the most important aspects in the center.
- There is only one stimuli at a time placed on the screen.
- During the lessons the students are able to manipulate different objects in order to provide them with an interactive learning experience.
- A teacher option menu determines what part of the lesson students will use.

Teacher Training

Practice throughout the years has confirmed the importance of the role of the teacher in this project. Neither the equipment, nor the programs nor the new methodologies have had the impact in the project as important as the participation of the teachers. The teacher makes the integration into the curriculum possible. For this reason, when we began with the project, we determined the necessity for the staff development needed for teachers to be incorporated in as a key element for the entire process. We designed a three phase training program.

First the teacher becomes an active participant and collaborator in the introduction of the computer as an element that supports the teaching-learning process. Three courses are given to the teachers that incorporate to the project. The courses are:

- Introduction to Computer Use.
- Analysis of the Methodology Used to Develop Educational Software.
- Educational Techniques for the Implementation of Educational Software in the Class Room.

When a new school incorporates to the project, it is natural to find that the teachers are afraid to use the new technology. To overcome this natural reaction, teachers are assisted by CICE´s experienced personnel during the first sessions. The active participation of CICE´s personnel continues, on a twice a month basis, until teachers and students feel comfortable with the system.

As a third training step CICE´s personnel have scheduled monthly meetings with all teachers from the schools involved in the project. During these meetings the following areas are reviewed:

- Subjects that will be taught during the next month
- Software lessons that will be used as an introduction to a new subject or to reinforce the concepts seen in the classroom.

It is important for teachers review the software lessons before they are used with the class. It is also important for them to use the software as an integral part of their math classes.

Application in the Schools

When a new school is authorized to be incorporated in the project they have to go through the following process:

Physical implementation of facilities

Based on specifications and recommendations provided by CICE the school authorities must implement an adequate dedicated computer center in their school.

Equipment acquisition

The equipment to be acquired by each school varies depending on the number of students in each group. Presently we are considering one computer for every two students. Equipment purchase is centralized at the Anahuac University headquarters where CICE is located.

Installation of equipment and software

CICE's specialized personnel are responsible for the equipment and software installation.

Teacher training

Software lessons application is incorporated into the design. As a rule, once a week each group should go to the computer center to reinforce what they have seen in their math class.

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Technology Planning: Recipe for Success

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Research conducted by the National Center for Technology Planning (NCTP) revealed that fewer than 30 percent of America's schools possess a written technology plan that is integrated into the curriculum. Although an increasing number of schools are considering the preparation of technology plans, relatively few educators know how to develop a technology plan that ensures success. Most school board members and district administrators confess to being confused about what strategic planning involves (Peterson, 1989).

Just as a cookbook has recipes that will lead to delicious cuisine, a technology plan has the potential for providing directions to success. The preparation of an effective plan should evoke the same devotion to excellence that one might find in the kitchen of a fine chef. All the necessary ingredients must be available for incorporation into the feast being prepared; however, not even the finest quality ingredients will yield the desired dish unless the recipe is explicit and is followed.

The National Center for Technology Planning (NCTP), established in late 1992 for the expressed purpose of assisting schools throughout the United States in their technology planning efforts, has amassed a large quantity of written technology planning documents. The documents, generally referred to as the "technology plans," vary in size, appearance, and scope. Certain essential principles exist, however, that serve as benchmarks to success.

Technology Plan Defined

Prior to achieving success with a technology plan, one must understand basic concepts of what a technology plan is—or should be. Definitions differ widely and often the unifying thread will be that "the way we do it" is best.

Cook (1988) asserted that the best examples of planning are based more on the collective intuition of those planning than on so-called hard data. Many cooks would give testimony that their intuition is what provides the deciding difference between success and failure in the recipe.

Rather than concentrate on the many specific elements that are needed within a maximally-effective plan, the focus should be on major points. After the "big picture" is conveyed and understood, a planner will be able better to address the minor, yet still important, elements.

A technology plan often is a document, and nothing more. However, in effective schools, the plan is merely the physical result of a major planning effort that focused on improving all segments of instruction, using technology in a natural infusion process. The plan, ideally, shows the total community that the school is dedicated to a particular goal, or set of goals, that will benefit the learners affected. Every good plan will include an aggressive thrust that extends beyond the range of "the ordinary" into a level to which the entire community must strive. The plan will cause all concerned to "reach" for the good stuff.

For purposes of this paper, a technology plan is defined as that written document that represents the very best thinking within a particular environment (school building, district, state, etc.) for the purpose of studying technology infusion, then recommending direction for the future.

Carlson, Gardner, and Ruth (1989) discovered that innovations and advancements in computer technologies often are excluded from organizations' long-range plans. The optimum plan commits to writing the dreams, aspirations, and visions of individuals involved in that community.

Steps in the Recipe for Success

As is the case with an effective recipe certain steps must be followed during preparation in order for the desired result to be realized. Too, if those who partake of the product consider it to be irresistible, others will want to share the recipe and enjoy its taste. A technology plan must be prepared with certain steps in mind.

Committee Representation

To ensure summative success, a technology planning committee must be established. This committee must represent all members of the school community — teachers, administrators, staff, business and civic leaders, homemakers, and, yes, students. A key point to remember is: "*involve all stakeholders*." Herman (1988) suggested that committees should be developed to promote ownership and collaborative decision-making. Members of the committee must perceive their participation to be of importance to the community. Each committee member must be provided with resources to perform assigned tasks. The committee chair must communicate clearly to all members the purpose and goals for which they are convened.

Progress Report

The chair should give a "state of the school" report so all members will understand current conditions in the school and the extent to which technologies are used for instruction and administration. Weak areas, as well as areas of strength, should be included so they can be addressed in the plan.

Information appearing in the progress report may, or may not, be included in the final technology plan. If the committee feels that these background data are beneficial, they should be couched in such a way to indicate that the report reflects historical information. Planners should be wary of introducing information into the plan that indicates hopelessness.

Subdivide Responsibilities

The technology planning committee will work most efficiently and effectively if the workload is distributed among its members. Hart (1988) recommends using several small groups to begin the planning process. One by-product of this approach is that each individual develops ownership in the process and the subsequent plan that emerges.

Each member of the committee must have specific responsibilities and must take seriously the responsibility that comes with the appointment. The outcome from this committee will be a working plan that leads the school district in application of various technologies to the instructional process in every grade at every school building for all students in the entire district—no small task. When each person performs a task at the level of excellence that must be expected, even demanded, the document that emerges will represent clearly and accurately a vision that can lure all involved into a bright future.

Cooper (1985) recommended that individuals who participate in planning identify major trends affecting the school district. When the group has agreed upon the identified trends, members can attack trends and see what their impact will be upon ongoing implementation enterprises.

Establish Time Frames

The technology planning committee must have a clear idea of the time required to prepare a written plan. This includes their understanding of all the prerequisite activities and considerations that lead to finalizing the planning document. Peterson (1989) noted that an organization simply cannot know what it is doing and what it intends to do unless it establishes and periodically monitors its goals—and the concomitant time in which it measures achievement of goals. Accomplishment of this requirement ensures that strategic planning occurs.

Time frames to be considered for adoption include, but are not limited to: length of time needed to complete committee work; assessment of district needs, of district technology inventory, and of district physical facilities; polling vendors to determine what technologies and related peripherals are available to address school needs; creating draft documents for areas addressed in the plan; acclimating district personnel to changes that may be recommended; educating community members; ensuring equitable representation by all constituencies in the district; preparing a financial proposal on costs; preparing a financial proposal for supporting investments required by the committee's recommendations; first-year implementation of the plan; potential for a phased-in approach to implementation; full implementation of the plan; evaluation of the plan, of the planning process, of the implementation process and of district personnel's response to implementation; and modification of the plan to incorporate findings from evaluations.

Establishment and publication of time frames helps to ensure that the technology plan will be implemented successfully. When committee members understand time frames and can communicate them to the community, chances for success are increased.

Set Target Dates

Target dates are essential for a technology plan to be successful. When time frames are considered and consensus is reached within the committee, the chairperson should entertain input for dates on which certain specific accomplishments can be expected.

Members of the planning committee will achieve individual and collective goals if well-defined dates are established. If the report on a particular task is scheduled for presentation at a specific meeting time, chances of acquiring and using that information have been increased significantly merely by setting a date (Green & Lamb, 1993, Malone, 1989). Use of Gantt or PERT charts can be considered to improve clear understanding of target dates within the committee.

Build Consensus

Consensus among the population affected by an organization is essential, but may be difficult to acquire. The technology planning committee must accept full responsibility for ensuring that the maximum consensus possible is gained. Many avenues exist, and models are available for review, for achieving broad consensus within the community.

The successful plan benefits each aspect of education in the local environment. When the planning team ensures that all players are represented in the plan, chances are improved that all involved will "buy in" to ideas contained in the plan. An effective plan will address needs of all segments of organizational life — administration and instruction alike (Fasano, 1987). One element cannot be represented to the exclusion of the other.

Various techniques may be employed in the quest for consensus. The complete plan must be explained fully to all stakeholders who are involved in the school. While the plan is being put together, consensus may be gained by ensuring maximum involvement by a wide collection of constituents. Those who "pay the bill" with taxes and other contributions must see the long-term benefits of the plan's implementation. If they sense a reasonably high level of participation, they will adopt ownership in the concepts and will give consensus gladly.

Formulate Plan

At this phase, the plan should be written. This section takes the least explanation, but evokes the most hard work. Here is where "the rubber meets the road"— results of the difficult decisions that emerged from examining and debating data appears in a defensible document. Specific considerations must be guaranteed to appear in the plan. The plan, in turn, should appear in various places within the organization's materials.

Elements of a successful technology plan will find their way into the organization's budget, curriculum, and job descriptions. The technology plan will not achieve maximum usefulness if it resides as a document alone, separate from other written materials which the give organization its direction. When the technology plan is part of the overall strategic long-range plan, the goals, missions, and visions embodied of the plan will be part and parcel of organizational activities—it will be integrated.

The chair must be certain that this document will be read by a wide assortment of school supporters (Dewess, 1988, Malone, 1989). Through careful writing the plan should have a pleasing, professional format projecting a positive, sure image. Care must be taken to guarantee that terms familiar only to educators are explained in a way that makes certain the reader will understand the intended meaning. Often, a committee will elect to present complex information in a pictorial form, usually in a chart or graph. The document should be bound in such a way that changes can be made without destroying the integrity of the plan.

As the committee organizes the sequence of the planning document, careful attention is given to the executive summary. As a general rule, the executive summary will appear at the beginning of the plan. Some readers may not have time to peruse the entire document; therefore, it is prudent that the executive summary appears first and portrays a clear representation of what the committee intends to convey to the public. Main points may be highlighted in a variety of fashions; a bulleted list, a sidebar, or boldfaced text printed in a variant typeface may produce the desired result. In any event, the executive summary should be given a place and appearance of great importance in the planning document.

Implement Plan

Educators are reminded by Smallen (1989) that planning, not just talking about planning, is necessary if optimal pedagogical use of hardware and software is to be realized. As trustees of public funds, educators can ill-afford to ignore this fact.

Implementation of the technology plan depends on full support from all members of the school community. Only when teachers are attuned appropriately to purposes of the plan, given sufficient ownership in ideas and opportunities for growth through the plan, and provided the level of training they deserve will they ensure full infusion of technological concepts into the curriculum.

Administrators, if committed to the plan, should make available all resources possible to see that implementation is realized. This may mean that role models are placed in strategic positions so teaching faculty may gain strength by seeing effectiveness demonstrated. Fledgling teachers and staff will be better able to put the plan into full action if perceived obstacles are removed and a reward structure is put in place so that all players may achieve success while the plan is working, too.

Evaluate Plan

Proper evaluation of an activity is essential: this is an accepted notion among educators. Certainly, then, the technology plan should be evaluated from numerous vantage points. While the plan itself should be scrutinized, activities surrounding the plan deserve ongoing evaluation, informally, and periodic evaluation, formally.

First, the planning *process* should receive evaluation. Committee members should evaluate their effectiveness and should encourage an external evaluation of the process through which they went to arrive at the implementation phase.

The planning document should be reviewed annually, with the most stringent review coming at the end of year one (Peterson, 1989, Randall, 1991). Subsequent reviews must take into account any recommendations that have been made during precedent evaluations (Tashner, Riedel, & Hutchinson, 1991). All previously identified aspects related to planning and implementing the plan ought to be scrutinized. Recommendations should be included in the annual report presented by the committee chair.

Role of Teacher Education Programs

The main focus of this paper is the development of the planning document, reflecting the interaction necessary among all components in the planning cycle. Teacher educators also have a tremendous responsibility, because we have an opportunity to create an environment in which preservice teachers may learn about and experience most aspects of technology planning.

Increasingly, teacher education programs require inclusion of computer literacy training (Arntson, 1991). Beyond that, a few are providing continuing experiences where preservice teachers use the knowledge and skills learned in literacy classes for projects and activities that strengthen relevance of technologies to their learning. Some few institutions guarantee that students create technology-oriented teaching materials and share those with fellow preservice teachers, often using the Internet as a conduit.

Teacher education, as a whole, faces a challenge to provide opportunities for preservice teachers to understand basic planning concepts along with their technology-rich experiences. If students graduate from programs in which they have learned the benefits of planning and are well-equipped to fashion even the most rudimentary elements of a technology plan, they will improve sharply the possibility of an education agency's implementing successfully a sensible technologically-inclusive program. A side benefit of preparing preservice teachers in this regard is that the training institution will, more likely, have a good plan of its own.

Resources for Planning

Technology planners do not have to concern themselves with collecting every single piece of information necessary to help them create and implement their plan. Numerous resources exist to make their job much easier.

The National Center for Technology Planning (NCTP) was established to serve as a repository for exemplary technology plans, as well as a place to acquire planning aids, public relations announcements, checklists, professional development opportunities, and to engender discussion and debate relative to a multitude of aspects surrounding planning. Planning documents have been procured from national and international sources; these have been placed in an archive accessible on the Internet via anonymous ftp, gopher, and by using Mosaic to access the home page at Mississippi State University (by loading a URL—http://www.msstate.edu). In addition to the online access, NCTP staff provide consultative assistance to schools, communities, and higher education institutions.

The Consortium for School Networking (CoSN) operates a gopher server (digital.cosn.org) that includes networking and technology planning assistance. Hundreds of practitioners are available, too, to give advice through the CoSN discussion list on the Internet. The Special Interest Group on Teacher Education (SIGTE), as a part of the International Society for Technology in Education (ISTE), conducts lively discussion on their listserv operated by Neal Strudler at the University of Nevada-Las Vegas (Strudler@nevada.edu).

The Scholastic Network, accessible through America Online, provides many technology planning resources. Along with offering downloadable technology planning documents provided to them by the National Center for Technology Planning, Scholastic Network operates a forum aimed at technology planning, specifically. Questions on planning, as well as technology implementation are welcomed.

Commercial computer manufacturers offer planning kits. Apple Computer's *Teaching, Learning, and Technology* is available in both videodisc and *QuickTime* CD-ROM format. IBM Eduquest has a technology planning packet that can be acquired from a regional Eduquest office. Both of these "for sale" resources contain a template that an organization may simply fill in, saving many hours of laborious polling, consultation, discussion, writing, and evaluating. The drawback to this approach, however, is that the educational agency will have produced a document that may be *called* a plan, but the true plan for the future has never been envisioned by the school. Such an approach is rejected vigorously by wise technology planners.

Conclusion

The desired outcome of effective technology planning is that the most appropriate technologies are infused in a natural manner into a maximally-effective instructional or administrative program so that all parties concerned have equitable access and achieve benefits from routine use of the technologies. Such a view is much like the desired outcome of an effective recipe: the consumer acquires excellent nutrition from a succulent dish prepared by an experienced cook who used the most appropriate equipment according to specific instructions (allowing user-adopted variances) in a relatively hassle-free environment to such an extent that others, even the consumer, want to know how he/she prepared the dish.

As educators use acceptable procedures and practices to create and implement technology plans successfully, other professionals will seek advice for their plans. One goal of leaders in the field of planning is to ensure that the highest quality of information attainable is spread among schools. If this recipe for planning is followed, then disseminated throughout the country, students in our nation's schools will enjoy a richer, more challenging, rewarding educational experience.

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A Realistic Approach to Technology Training for Practitioners: The West Georgia College Model

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West Georgia College

Technology Restructuring

Teacher education institutions are taking a more active leadership role in todays' educational restructuring movement. Teaching collaboration, shared decision making, effective teaching methods, and how to build school rapport are all on the faculty-schools system agenda for school renewal. One area of great importance for schools of the future is the use of technology. Educational journals are filled with advertisement on computers and software, and most journals also include a page or two on technology describing the pros and cons of several teaching experiences (Elliott, 1993; Sanders, 1993). College instructors are familiar with word processing and rely on computers for their writing; yet many of these same instructors are not as skilled as they need to be in order to assist school districts in their restructuring, particularly when the restructuring efforts involve the technology training of practitioners.

Educators at the school district level (media specialists and classroom teachers) are having a difficult time keeping up and integrating these newer technologies into the curriculum (Grandgenett & Mortenson, 1993; Resta, 1993, Smith & Smith, 1993). College and university personnel are caught in this same situation. Most faculties haven't had the time or staff development to learn the newest technology or to actively experience working with new programs.

In an effort to meet the challenges of providing needed technology training to both teacher educators and practitioners in the region, the School of Education at West Georgia College (WGC) provided a series of technology development sessions during the 1992-1993 academic year. This article describes the staff development and college sponsored training model that was delivered. Program outcomes, suggestions for program improvements, and educational implications are also described.

The Technology Program

The goals of the technology staff development program were twofold: to identify the technology needs of faculty and to provide the technology training in the expressed areas of need through a series of workshops. It was believed that educators would more readily integrate the new and emerging types of technologies into their teaching practices once they became familiar with how to operate the equipment and were exposed to a variety of effective classroom applications with the various types of technology. Hands-on learning opportunities allowed the participants to become more comfortable with the equipment. The Dean of the School of Education and department chairs strongly supported this faculty development venture and appointed a coordinator to design and implement the training program.

The Design Phase

The technology coordinator designed and administered a needs assessment questionnaire to faculty in the School of Education during a end of a summer session. Respondents were asked to describe the technology training they needed, including training on the equipment as well as selected software; to list technology sessions they would like to conduct as part of the series, if any; to identify technology experts in the area that could be contacted to make a presentation; and to recommend days and times they would be most available to attend the training sessions.

Thirty-five of the 72 questionnaires were returned (49%). Fifteen different technology content areas were identified, ranging in frequencies from 10 faculty requests to 1 for similar programs. Based on the frequency of those requests; the availability of the presenters, the specific technology hardware and software, and the technology training room; and the immediate needs of faculty; the coordinator scheduled the training sessions for the fall, winter, and spring quarters.

Promotional flyers were developed and distributed to faculty the first day of the fall quarter. The flyers listed the areas of training as well as the fall training schedule. This information included the day and time of the sessions, room location, name of the presenter, and a brief summary of the nature of the session. In addition, the flyer contained a return postcard. Participants were asked to check of all the sessions they planned to attend and to return the postcard within a certain time frame. This feedback gave the coordinator an opportunity to make plans for the sessions and to ensure the rooms and instructional materials were appropriate.

Originally the promotional technology flyers were sent only to faculty and staff in the School of Education. Due to requests from other interested administrators and educators off campus, the flyers were also distributed to superintendents, principals, media specialists, and staff development personnel in the region for winter and spring quarters.

The Implementation Phase

Attendance at the training sessions was on a volunteer basis. Department chairs encouraged individual faculty members to attend those sessions that would contribute to their professional development.

Since the majority of the faculty in the School of Education taught classes Monday through Thursday, all of the training sessions were conducted Friday mornings from 10:00 a.m. until noon. Depending upon the size of the audience and the type of technology needed, a number of technology sites in the School of Education were used. Twenty seven technology sessions were delivered by 15 technology experts in the area. Eighty percent of the training was conducted by faculty in the School of Education while 20% was delivered by experts in the region interested in participating in the program. Seven sessions were conducted fall quarter, 10 winter, and 10 spring quarter. Table 1 categorizes the types of technology training sessions that were delivered during the year and the number of times each session was conducted.

Table 1
1992-1993 School of Education
Technology Training Sessions

Type of Technology Session Delivered	N
1. Applications of Selected Computer Software Programs:	7
PageMaker (2)	
JMP (1)	
Scantron (1)	
Slideshop (1)	
Statview (1)	
VCR Companion (1)	
2. Computer Utilization Skills:	5
Apple and Macintosh - Beginning Level(2)	
Apple and Macintosh - Intermediate Level(1)	
IBM - Beginning & Intermediate Levels (2)	
3. Instructional Video:	3
Planning and shooting instructional videotapes (2)	
Editing 1/2 inch videotapes (1)	
4. Multimedia:	3
HyperCard (1)	
Illuminated Manuscripts (1)	
Linkway (1)	
5. CD-ROM Technology:	2
6. Photography:	2
Shooting black and white photography (1)	
Making black and white prints (1)	
7. Integrating Technology into the Curriculum: Effective Techniques Utilizing the New and EmergingTypes of Technology	1
8. Making Powerful Presentations Using Graphics, Verbal and Nonverbal Language, and Dress	1
9. Long Distance Learning (the fiber optics connection between West Georgia College and Carrollton City Schools)	1
10. Laserdisc Technology	1
11. Audiovisual Support Services offered by the Learning Resources Center at West Georgia College	1

Outcomes

Observations and input from the participants in the training series have identified several positive outcomes as a result of this technology training staff development program. The benefits to trainers, college faculty, teachers and other support personnel from the districts include:

1. a greater awareness and interest in technology, especially the new and emerging technologies,
2. "hands on" learning experiences with new and emerging types of technology,
3. an increased knowledge of a variety of ways to use technology in the classrooms,
4. knowledge of content-specific software and their effectiveness with students,
5. a greater use of technologies that exist in the School of Education,
6. a decrease in the "fear" of technology,
7. a greater demand for technology, and
8. an increase in the use of technology in the classroom for instructional and learning purposes.

The benefits to schools in the region:

1. an opportunity for free staff development training for teachers,
2. an opportunity for sharing staff development needs with teacher training institutions,
3. an increased utilization of available technology within the school and the School of Education, and
4. an increased awareness of the types of technology on the market and present or future needs of the school.

The benefits to the School of Education at WGC:

1. an opportunity to provide service and leadership to the region in technology training,
2. an increased awareness of the types of technology training needed by practitioners,
3. a chance to become further acquainted with the schools and its personnel in the region,
3. an opportunity to recruit graduate students, and
4. another opportunity to form cooperative partnerships with educational leaders in the region to enhance the the teaching and learning practices of all educational personnel through the sharing of human and nonhuman resources.

Overall the technology sessions were successful and fairly well attended. Participants included administrators, teacher educators, teachers, media specialists, and librarians from both on and off campus. The demographic data that was collected with regard to the participants and presenters are shown in Table 2.

As a result of the success of the 1992-1993 training series and the requests from educators both on and off campus for additional training, the series has been extended another year.

Suggestions for Improvements

Those attending the sessions expressed some helpful suggestions for improving the sessions. These included:

1. Videotape the training sessions so that faculty and other interested personnel can view the instruction at a later date. In cases where faculty need the training but have other commitments or classes at the time of the session they could easily view the tape during their free time and benefit from the provided instruction.
2. Provide training sessions at other days and times since some faculty are scheduled to teach on Friday mornings or offer the sessions once in the morning and once in the afternoon.
3. Since teachers often have very busy schedules, send reminder notices to those who have signed up for the specific sessions or call the day before the session to jog their memory.
4. Provide more opportunities for participants to play with the technology after the session or at later dates. This would ensure that appropriate practice has taken place and that participants had not forgotten what they had learned.
5. Send the technology training flyers to the support staff in the School of Education at West Georgia College as well as faculty from the other schools in the college.

Table 2
Demographic Data
on the Technology Training Sessions

Category	Frequency
Number of sessions delivered	27
Number of Participants	181
Number of different participants	70
participants on campus (61)	
participants off campus (9)	
Average number of participants each session	7
Average number of sessions attended by each department in the School of Education	8
Number of different presenters	15
from on campus (12)	
from off campus (3)	

Implications

Time and information often out paces the best of people and leaves little time to apply all the new technology available. By utilizing staff development at the college level, professors receive current "hands on" experience in their disciplines rather than just reading articles about the newest technologies. This allows them to model those practices and to become more credible to their students.

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A Three Year Plan to Infuse Technology Throughout a Teacher Education Program: Year 3 Update

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Introduction and Background Information

Researchers and practitioners seem to agree on the need for quality, integrated technology experiences for preservice teacher education students (Bitter & Yohe, 1989; Bruder, 1991; Strudler, 1991; Walker, Keepes, & Chang, 1992; Wetzel, 1992; Davis, 1993). If new teachers are to use technology effectively with their students, they must have appropriate experiences and instruction throughout their preservice program. Creating models for educating faculty and successfully infusing technology throughout the preservice curriculum has been problematic, however, for teacher educators. In this paper, a program designed to support faculty and thus integrate technology into teacher education will be described, with special emphasis on activities in the third year of the program, 1993-94.

The faculty education program described in this paper is part of a larger program developed over the past ten years in the College of Education at Iowa State University. The program is designed to make technology an integral part of the teaching and learning environment. The first two components of the program are part of the curriculum for all teacher education students; the third component is designed for students who wish to specialize in the area of technology. The program, designed to model the uses of technology classroom teachers, the former preservice students, will be using with their own students, includes the following three components:

1. a course in computer-related technology
2. computer-related technology experiences in foundations, methods and field experience classes
3. an optional minor in educational computing that includes eighteen credits of coursework in computer-related technology topics.

The program described in this paper was designed to enable the second component of the technology program.

Technology Integration Throughout the Teacher Education Program

Single course approaches to teaching teachers about technology are clearly not enough to help preservice teachers create a vision of how technology can expand their own teaching. Most teacher educators would agree, however, that infusing technology into the entire teacher education program is a much larger challenge than designing and implementing a single course. Technology integration into the foundations, methods and field experiences is a continuing area of emphasis in the teacher education program at Iowa State University, and the three year program in this area has resulted in steady progress in faculty involvement in technology infusion.

During the first year of the infusion program (1991-92), teacher education faculty obtained computers and attended workshops on computer applications. Year 1 activities focused on helping faculty get up and running with their computers and on helping faculty learn to use the computers to complete their work. During Year 1, there was little emphasis on using the computers for instructional purposes. During the second year of the project, workshops continued and individual faculty were encouraged to work with mentors (primarily instructional computing graduate students) to begin to design technology applications for their classes. An internal department communication system using Quickmail was also established during Year 2.

In the third year of the project, mentoring activities increased and included almost all areas of the curriculum. Some activities that have emerged from this mentoring process include the development of reading-writing activities that incorporate technology, the use of telecommunications as a vehicle to communicate with elementary students throughout the writing process, the participation of math, science and social students in simulations, the use of distance education capabilities to connect teacher education students with K-12 classrooms, student use of presentation software to prepare projects for classes and the use of commercial software for tutoring elementary students.

Although faculty were never required to participate in any part of the program, technology integration was adopted as one of the department goals for each of the last three years. Thus, many faculty chose to incorporate increased use of technology in instruction in their own yearly goals and this was encouraged by the department chair.

Year 3 Environment

By the 1993-94 academic year, technology had become a relatively routine and natural tool for a good proportion of the teacher education faculty and thus influenced the way the department conducted its business. Telecommunications capabilities influenced both internal and external communications. Faculty were connected internally with Quickmail in Year 2 of the project and use has increased steadily each month. Given the ease of use of the Quickmail system, it became a method for getting some of the more reluctant faculty established as regular computer users. It also provided a friendly introduction to electronic mail and thus an introduction to the more complex Internet system. Internet workshops were provided for faculty in Year 3 of the project and an increasing number began to use this capability.

As documented by department secretaries, the majority of faculty were doing their professional writing, course preparations, and correspondence with their computers. By Year 3, the secretaries' work loads had changed dramatically; they were used to check, format and print documents, but not to enter text. The secretaries began their own work with computers at about the same time as the faculty and by Year 3, several of them were "experts" on the finer points of Microsoft Word and Works.

The computer also became a part of department meetings during Year 3 of the project. Committees began to present their reports using Power Point and the computer and LCD became an integral part of activities at the meetings.

In summary, by Year 3 the computer had become a vital and natural tool for the work of the department. Faculty, staff and students regularly shared computer and software information with each other, the areas where the community laser printers are housed became meeting places for faculty waiting in queues. Faculty and students were regularly checking out computer hardware and software for instructional purposes.

Specific Integration Activities

Technology activities within the instructional program became much more common during Year 3 of the project; a small sample of these activities were selected for description in this paper.

Several instructors began to use the Xapshot system as a means to help them get to know their students more quickly and efficiently. Students would take their pictures with the Xapshot and then write a short introduction of themselves, complete with picture, for their instructors. Many students were enthusiastic about using this same procedure with their own students.

One faculty member in reading and language arts used the Internet to connect her methods students with the fifth and sixth grade classes at the Apple Classroom of Tomorrow site in Blue Earth, Minnesota. The fifth and sixth graders e-mailed their written products to the teacher education students who commented by the products. Students at each site had pictures of their e-mail partners on bulletin boards. The fifth and sixth grade teachers reported increased student interest in writing given the collect student audience and the college students expressed sincere appreciation for the opportunity to get to know the fifth and sixth graders and their writing abilities.

Another reading faculty member used the distance education facility and the Iowa fiber optics system to connect her secondary reading methods class with both 8th grade students and their teachers. Initially, the teacher education students met the 8th graders over the fiber optics network and each group had the chance to see and interview the other. During the semester, the teacher education students received written products from the 8th graders by e-mail and also had the opportunity to meet with the 8th grade reading teachers over the fiber optics network. At the end of the semester, the teacher education students and the 8th graders had a final face-to-face meeting over the network. Enthusiasm for the project ran high on both ends. One teacher education student remarked:

At first, we were all real nervous about the system and the cameras; after while, though, you could just feel everyone relax and enjoy the opportunity. I plan to use this system with my own students someday.

Math and science faculty members in the department are making use of a technology rich teaching classroom funded by the National Science Foundation to integrate technology throughout their teaching. The classroom features six fully equipped stations that include computers, Xapshot capabilities, laser disc players and CR-DOM. Science methods students regularly use computer interface software in conducting experiments; math methods students use Logo, spreadsheets, and problem solving software as a regular tool in their classes. Video disc material helps make science real for the teacher education students as do science and mathematics simulations.

Another significant aspect of the technology integration program is the increased student use of technology to complete class assignments. Students who have taken the computer course are increasingly using Hypercard and Power Point and other tools to prepare their class presentations. The power of the graphics, video, and audio used in some of these presentations is an impressive force for faculty and students alike.

Challenges

All faculty participation in the integration project has been voluntary; neither workshops nor mentoring activities are required. Thus, there are still some faculty in the department who make little, if any, use of technology in their teaching or their professional work. This number is, however, steadily diminishing and both peer and student pressure is making it clear to all that technology is increasingly a scpart of department work. As students regularly fulfill assignment though using technology, even reluctant faculty are finding it difficult to ignore the power and potential of technology. As Quickmail becomes an increasingly important part of department communications, those not on the computer regularly begin to see the need for regularly accessing mail. Taken together, the growing computer culture within the department will continue to be a powerful force to lure more and more faculty into effective and creative computer use.

Keeping current in hardware acquisition is a continuing financial problem. Most of the department equipment has been funded through internal and external grants; as faculty become more sophisticated in their use of technology, there is increasing pressure to increase the funding for technology. Computers purchased two years ago no longer meet some of the faculty' needs; replacement is already an issue. Traditionally, Colleges of Education do not have equipment budgets that will support today's technology needs. Funding continues to be a challenge.

Summary

By the end of the third year of the preservice technology integration project, technology had become a natural tool for conducting research and teaching in the teacher education program at Iowa State University. Although a few faculty still had not become regular users, most had become a part of a community that used technology for communication, research and instruction. In retrospect it appears that several features of the technology integration program were important in contributing to its success:

- furnishing all the faculty easy access to technology
- not pushing instructional use of the computers until the faculty became comfortable with personal use
- including technology integration as a yearly goal for the department during each year of the project
- strong support from department and college level administration
- not requiring participation in the program
- one-on-one mentoring for interested faculty

Future plans for technology infusion include offering more advanced workshops, continued mentoring, and a newsletter sharing faculty and student projects ideas.

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Using Myers-Briggs Type Indicator As A Tool For Developing Successful ITTE Programs

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Broadly defined, technology is "the invention of any tool that makes a task easier" (Yopp, 1993). In instructional settings this definition includes new and powerful technology in the form of computers, networks, modems, CD-ROM, multimedia tools, and software for use in almost any subject.

Reactions in the educational community to this new technology are mixed. While some regard technology, and their accompanying equipment, as tools that might enhance teaching and learning, all this new power is meaningless unless teachers themselves take ownership of it. As Meade (1991) says, "Without ready and willing teachers, [this] technology can accomplish nothing" (p.30).

Today's educators face the critical challenge of incorporating technology into training programs that will foster ownership of the technology and bring positive benefits to both the teachers and students in our schools. Although some state legislatures and boards of education have mandated some type of technology training (Gursky, 1991), the need for, and the structure of, the instruction have not received adequate thought. Shao (1989) notes that "after a decade of enthusiasms, there's still no clear consensus about the role, value, or effectiveness of computers in schools. Well-thought-out goals are still lacking" (p. 108). Yet, the structure of technology training affects teachers' attitudes toward computers and "may ultimately affect the teacher's competence as a source of instruction" that includes technology (Brownell, Brownell, and Zirkler, 1993, p. 137).

Many training programs treat all teachers the same by using identical forms of instruction. Too often, professors and administrators adopt a "one best way" approach to preservice and inservice programs that does not consider the "individual competency levels, needs, interests, professional maturity levels, and personal characteristics of teachers" who participate (Sergiovanni, 1987, p. 149). Concerned that "there is no single foolproof way" to provide instruction, Centra (1979, p. 3) recommends combining information from several approaches to avoid bias and to maximize results for teacher education.

Some prospective teachers regard computers as just another thing for them to teach, rather than something that could make their lives easier (Koepke & Ladestro, 1991). In addition, teachers have a higher level of computer anxiety than their students, and often feel psychologically at risk when exploring the use of new technology (Cambre and Cook, 1984; Hermann, 1988). Webler (1992) agrees that one reason teacher education majors are not receiving instruction in computer literacy and applications is because computer anxieties interfere with the learning process. To overcome this anxiety the uniqueness of the individual teachers must be central to the instruction that is designed, with the participants being actively involved (Dobson, Dobson, &Kessinger, 1980).

Individualization in Technology Education

One approach to individualizing technology education is to use the Myers-Briggs Type Indicator, (MBTI or the Indicator) (Briggs & Myers, 1977). Its purpose is to clarify

Jung's theory of psychological types. The essence of his theory is that what may seem random behavior is actually quite consistent, because of basic differences in the way individuals prefer to use their perception and judgment (Myers and McCaulley, 1989).

Four preferences are scored on the MBTI to determine a person's type: (1) **E**xtroversion, the outer world of actions, objects, and persons, or **I**ntroversion, the inner world of concepts and ideas; (2) **S**ensing, the practical facts of experience and life, or i**N**tuition, the possibilities, relationships and meanings of experiences; (3) **T**hinking objectively and impersonally, or **F**eeling subjectively and personally; and (4) **J**udgment in a decisive, planned and orderly way, or **P**erception in a spontaneous, flexible way. The highlighted letters designate the eight characteristics, four of which combine to define a participant's type.

Diversity still exists within the 16 possible types. Some people are more differentiated, or at a higher level of type development than others (Lawrence, 1987). All of the 16 possible types are represented among teachers who have answered the MBTI, however. Each has its strengths and limitations and, in turn, makes special contributions to teaching.

Learners at all levels are also represented among the 16 types. At times, they need the support of an instructor who is like them in type, because understanding comes more easily between similar types. At other times, they need the challenge of being with an instructor of a different type. Finding the right balance between support and challenge is an important task for those who plan instructional programs and staff development activities. If participants include a mixture of types, and, if those who work with them understand the strengths of each type, the preservice or inservice training can be more effective.

Research from the data bank of the Center for Applications of Psychological Type in Gainesville, Florida, indicates the following type preferences exist among teachers. The level of i**N**tuitives increases with college instructors. **F**eeling types are in the majority through high school, with **T**hinking types outnumbering **F**eeling types in college teachers. As a result, teacher education programs can easily involve i**N**tuitive **F**eeling types imposing their preferences upon **S**ensing **T**hinking types. At all levels, **J**udging types outnumber **P**erceptive types, with administrators having even more **J**udging types than do teachers.

Certainly, all learners need an environment that will offer the best opportunity for their development. Type theory provides new insights into how to match learning settings to individuals.

MBTI Results in One School District

The author initially introduced the MBTI to a western school district as part of a naturalistic study of four teachers involved in an individualized evaluation process. Other teachers and staff members asked to complete MBTI Form G, which was used for the study. Scores were recorded for 23 members in the district, eight men and 15 women, on a scale of one to 70 for each of the eight areas of preference.

The 23 respondents represent 12 of the 16 possible type combinations. All expressed surprise at how well the description of their type "fit," and were interested in knowing which teachers scored their same type.

The author, as an administrator, had to learn first about her own perceptions and ways of interaction. Second, she worked to understand the views of the individual teachers, both about themselves and about their setting. The next step involved discovering ways to combine her style with those of the different teachers in order to promote their personal ownership of a technology process designed for improvement.

Myers and McCaulley (1989) suggest MBTI results such as these can help instructors to develop diverse teaching methods to meet the needs of different types; understand type differences in motivation for learning; analyze curricula, methods, media, and materials according to the needs of different types; and help instructors, administrators, and teachers to work together more constructively. Staff development programs for this audience needed to employ approaches appropriate to the preference combinations illustrated in the 23 participants.

Indeed, the author found that district teachers were more concerned with accumulating easy credits to advance on the salary schedule that in gaining knowledge. While some personal pressures may lie beyond an instructor's range of influence, they can affect motivation in some respects. One way is using the strengths of the 16 type differences to increase motivation for learning.

Lawrence (1987) suggests dividing motivation into four parts, corresponding to the four dimensions of type shown by the 23 teachers:

1. The extraversion-introversion preference shows the broad areas of natural interests.
2. The sensing-intuition preference reveals basic learning styles.
3. The thinking-feeling dimension shows patterns of commitments and values.
4. The judging-perceiving dimension shows work habits.

By considering these four natural motivators when planning instruction—by working with them rather than against them—instructors can better direct a person's energy toward learning and accepting new ideas and concepts.

Conclusions about Individuality

Growth and change can be uncertain and even threatening. However, in the presence of caring and concerned supervisors, what Levine (1989) called a "context of support," educators can benefit from teacher education programs designed to increase their self-awareness and progress.

When type differences are seriously considered, teachers then experience the challenge of reaching individuals of opposite types. In type development, all learners need to develop **S**ensing, i**N**tuition, **T**hinking and **F**eeling. For each type, two of these processes come easily, and two are difficult. Teacher education programs built on a foundation of type study can help learners discover their own preferences. Then they can help them develop expertise in these four *mental* processes—first, by increasing their abilities in the processes that are easiest for them, and later, by developing their ability to use the others (McCaulley and Natter, 1974).

Furthermore, teacher education programs can help participants learn when to use the four *attitudes*. Extraverted participants can learn how to enjoy their own company and thoughts. Introverted participants can learn the skills of extraverting in order to have more experiences to think about. Judging participants can learn when to keep an open mind and to stay curious and receptive. Perceptive participants can learn to stop perceiving and make a decision.

Until recently, most education literature had overlooked the importance of individual attributes (Strike & Bull, 1981). Fortunately, a growing number of authors are emphasizing the importance of difference among educators. This increased interest suggests that schools should consider carefully the implementation of any education system or technology training that does not allow for diversity among its members.

From the information furnished by 23 members of her school district, and by other reports, the author concluded that the better the understanding a staff development facilitator has of a participant's unique characteristics, the better formed will be any process employed for change or improvement of that instructor. Facilitators and teachers who understand that participant and student temperaments do use this information in determining how they will teach (Lawrence,1987). The MBTI gave the presenter a basis for understanding each participant's perceptions about technology, as well as providing each informant with an opportunity to examine, and accept or reject the findings.

As early as 1978, Reavis championed the involvement of teachers in suggesting training objectives. Too often, he said, supervisors may be promoting their own preferred styles, and not necessarily those of the teachers. Therefore, they must develop ways to understand and work with the individual differences found in teachers. This understanding of the role of supervisors would also apply to teachers and staff developers. Since Reavis' assertion, the amount of literature supporting individualization has continued to grow. The notion that teachers are assembly-line products (Bredeson, 1987) is no longer considered acceptable to an ever-growing number.

Results

As a result of this report, the author concluded that, for ownership and acceptance of technology in teacher education, the training must begin at whatever point the individual is able and willing to begin. Along with beginning at the stage acceptable to the learner, the author concluded that a few targets reached are better than many that are ignored.

Preferences of each individual must always be considered when acceptance of new programs is sought. Teachers react to criticism or suggestion in different ways, just as they perceive their needs differently. While one might accept a direct, firm approach, another may need a gentler less-direct technique. Since continual improvement should be a major concern for all educators, the author also concluded that professors and administrators who lack appropriate interpersonal skills need to attend seminars and classes, and study current literature to develop their understanding of differences.

While time periods for preservice and inservice may reach an end, the process of individualization does not. Consideration for the individual should be ongoing so that teachers do not reach a midcareer point where they simply go through the motions or, even worse, retire on the job (Evans, 1989).

Recommendations

Based on the conclusions of this report on technology and the importance of individualized teacher education, it is recommended that

1. All those involved in the education of teachers first endeavor to understand their own uniqueness. For communication and understanding, one instrument, such as the MBTI, may be used by all assessors at a particular site.
2. Professors and administrators then endeavor to understand the uniqueness of each teacher, so that the instruction process can be individually tailored to meet the needs of the particular individuals.

Summary

This report provides significant information about the importance of planning for individualization in teacher education programs. McCaulley and Natter (1974) stress that, as schools improve their capacity to help each type develop its potential, there will be less visible dissatisfaction, and less underachievement. Additionally, a group of individuals will learn to effectively direct their lives, and to value the important contributions of all types of people.

All individuals have the right to a learning setting that will offer them their best opportunity to develop (Lawrence, 1987). The MBTI provides insights into how to match learning settings to students. It is unrealistic, however, to ask teachers to totally change their need for structure.

The author suggests two possible alternatives to the mismatch between instructor and learner needs. First, individuals can be placed in a setting that allows the best match between teacher style and learner need for classroom structure. Second, teachers can learn techniques for varying structure, techniques that permit them to meet more people's needs, without forcing them beyond their own capabilities.

From this report, it is apparent that considering the needs of the individual can lead to improvement in teacher education and provide less discomfort about technology for the learner. The teacher may then have the confidence to experiment, grow, and change. Indeed, when they realize that there is little to fear, then their ownership of technology as part of the education process will become a useful tool toward overall improvement in all levels of education (Conley & Dixon, 1990).

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Leveraging Pedagogical and Technological Transformation Simultaneously: K-12 and Higher Education

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Given the pace of technological transformation and related pedagogical restructuring and the expanding gap between the leading edge of change and many university and K-12 faculty, research projects and model development seem implicated to leverage change in both Higher Education and K-12 faculty simultaneously. In addition, the variables that effect change in social systems have been identified by over 50 years of diffusion of innovation research, yet practitioners infrequently utilize this knowledge in planning and implementing technological restructuring projects. This paper reports initial findings of a multi-year field experiment case study and diffusion of innovation model testing that involves university and high school faculty in the introduction of multimedia technology and constructivist-based teaching practices.

Background of the Study

In the spring of 1993 the researchers were awarded two grants to develop and test a model for leveraging simultaneous technological and pedagogical change at the K-12 and higher education levels. The model seeks to create a community of learners in which university faculty from the content area (college of arts and sciences) and the teacher education methods area (school of education) are engaged as part of a research team to observe and evaluate the effects of multimedia technology and accompanying constructivist-based teaching practices on a high school instructor's teaching methods and curriculum. The primary research questions have been:

1. Does the university faculty involvement in K-12 restructuring innovation process change their own curriculum content and teaching practice?
2. Does this type of synergistic learning community approach demonstrate any potential as an effective vehicle for simultaneously impacting higher education and K-12 restructuring?
3. Can researchers identify, monitor, and adjust the key variables identified in the diffusion of innovation research literature and thereby increase the probability of effecting change?

Technological Change and Transformation Literature

Thousands of articles, books, and research reports have been written regarding the relationship between K-12 educational reform and technology. Many researchers and writers have concluded that technology is a key factor in the etiology of the educational reform movement, or at least a required partner. The need to increase the use of technology in Teacher Education programs has also been identified as one of the key issues in educational reform (Ely, 1990; Pina & Savenye, 1992).

One area of educational technology that has received increased interest in recent years is the use of multimedia in classrooms, and particularly in Social Studies curricula (Bednar, Cunningham, Duffy & Perry, 1991; Ely, 1990; Gayle, 1991; Martorella, 1991; Maxey-Fernlund & Cooper-Shoup, 1991). The infusion of multimedia materials into classrooms across the nation has increased research interest into the effectiveness of multimedia materials. Numerous researchers have studied the effectiveness and efficiency of multimedia materials at various learner levels, from the military to first grade students to training elementary teachers (Carlson & Falk, 1990; Gayle, 1991; Pina, 1992).

The process of how to successfully incorporate multimedia materials into traditional classroom settings has also received increased study. Although currently the subject of much heated debate, many researchers conclude that additional pedagogical innovations in the form of Constructivist Learning Theory based practices are required in order to realize the full potential of multimedia technology (Bagley & Hunter, 1992; Bednar et al, 1991; Cunningham, 1991; Duffy & Bednar, 1991; Johnson & Vaughn, 1992; Jonassen, 1991; Perkins, 1991; Strommen & Lincoln, 1992; Volker, 1992).

Diffusion of Innovation Literature

Diffusion of innovation researchers have studied the social change process for over 50 years. Over 3,000 studies have been conducted which have identified a number related variables in the adoption of innovation process.

Diffusion is defined as "the process by which (a) an innovation (b) is communicated through certain channels (c) over time (Rogers, 1983, p. 5). Rogers identified a number of key variables in the diffusion of innovation process in his meta-analysis of the research. A graphic representation of the innovation-decision model is provided in Figure 1.

Diffusion of innovation research also suggests the development of a concept that has received much attention in education and in the change literature in other fields as well, *Learning Communities*. As Rogers (1983, p. 68) states in his meta-analysis, "A social system is a kind of collective-learning system in which the experiences of the earlier adopters of an innovation, transmit an innovation through interpersonal networks." Developing effective *learning communities* and an organizational culture that values learning are perceived by many as essential in the current era of rapid change and restructuring. Effectively maintaining the velocity of organizational innovation by developing a *Learning Organization* is seen as a necessity for organizational survival in the process of restructuring current practice into a new organizational milieu (Bolman & Deal, 1991; Senge, 1990).

This study therefore combines multimedia, cooperative learning, and process writing into what is known in diffusion of innovation literature as a *technology cluster*. This cluster of interrelated components is considered the study innovation which has been the focus of attention and active research by a community of university and school district learners/researchers. The development and ongoing facilitation of the learning community is also being managed by the researchers according to salient variables identified by diffusion of innovation research.

Research Methodology

This qualitative study methodology is a hybrid design that might best be described as a *heuristic, interpretive field experiment* (see Merriam, 1988, pp. 13 & 27; & Rogers, 1983, p. 70). The study was designed to expose the participants to the study innovations, measure their response, and at the same time permit the researchers to modify, test, and confirm variables identified in the diffusion of innovation models and research. The types of data collected have been qualitative and quantitative with the majority being qualitative in the form of several hundreds of pages of transcribed interviews and spontaneous conversations, correspondence, course syllabi, and participant and researcher notes.

Structured interviews were developed by the researchers to pre-sample study participants on various innovation research variables that have been identified as important factors in innovation studies. In the Spring of 1993, initial recorded and transcribed interviews were conducted and other field materials were collected to establish descriptive baseline information regarding current attitudes, awareness, and knowledge of the study innovations and participant teaching. School district administrators were also surveyed to help determine the innovation history and potential of the high school and school district.

The university faculty observed the high school teacher's traditional *textbook, lecture, test* classroom in the Spring of 1993 and talked with the instructor. Over the Summer and Fall of 1993 the high school instructor was inserviced by the senior researcher and the school of education cooperative learning specialist on cooperative learning, process writing, and multimedia computer technology.

The original research plan called for another university faculty visitation in the Fall to observe any difference after the innovations were adopted. The high school teacher's training, however, took a great deal more effort and time than anticipated continuing into early winter, thus postponing the second visit by the university faculty. Participant response to the initial innovation intervention was not available at the time of this writing. These findings will be presented at a later time.

In addition to cassette recorders, transcription machines, portable Macintosh powerbook computers, and video taping equipment, the researchers also utilized specialized software programs: (a) a Research Notetaker *HyperCard* stack written by the senior researcher; and (b) a commercial qualitative research analysis package called, *HyperResearch*. All data, except the video taped classroom segments, was digitized and data analysis involved the use of computers. Grant funding paid for computer hardware and software and travel expenses. The university faCulty study participants were paid a small consulting honorarium as an incentive for participation.

Results and Discussion for Future Research

Because of the complexity of the study and the innovation model itself, only a fraction of the study results will be reported.

Potential adopter understanding and workable knowledge about the innovation is essential in the innovation-decision process. An innovation "is an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1983, p.11). The researchers found that although all of the respondents had awareness of the names of the innovations, not one of the subjects had a clear understanding and working knowledge of all three innovations. Predictably, none of the participants understood how the components related to one another in relation to instruction.

This lack of knowledge skewed the study participants' perceptions about the characteristics of the innovation. The rate of adoption of an innovation is directly related to the amount of innovation information present in the environment, especially during the persuasion *stage* of the innovation-decision process. This information acts as a basis for decision making. The individual's decision to adopt or reject is effected by how she/he perceives an innovation's: *Relative Advantage* (what is gained by adoption), its Compatibility with past practice (thereby assuring some reduction in the uncertainty of effects of adoption), its Complexity (the relative ease of understanding and using it), its *Trialability* (the ability of the potential adopter to make limited test uses of the innovation); and its *Observability* (the ability of potential adopters to observe first hand the effects of adoption). (See Figure 1.)

Relative Advantage

1. All participants expressed a perception that adopting all of these innovations would provide some relative advantage to the instructor.
2. The value that every participant expressed as being the ultimate measure of *relative advantage* of adoption was "increased learning and motivation of students."
3. Nearly all participants had a negative attitudinal connotation to the word, *status*, which rendered the data on this question invalid. No one wanted to admit to desiring or even having others perceive them as seeking increased "status" in any form.

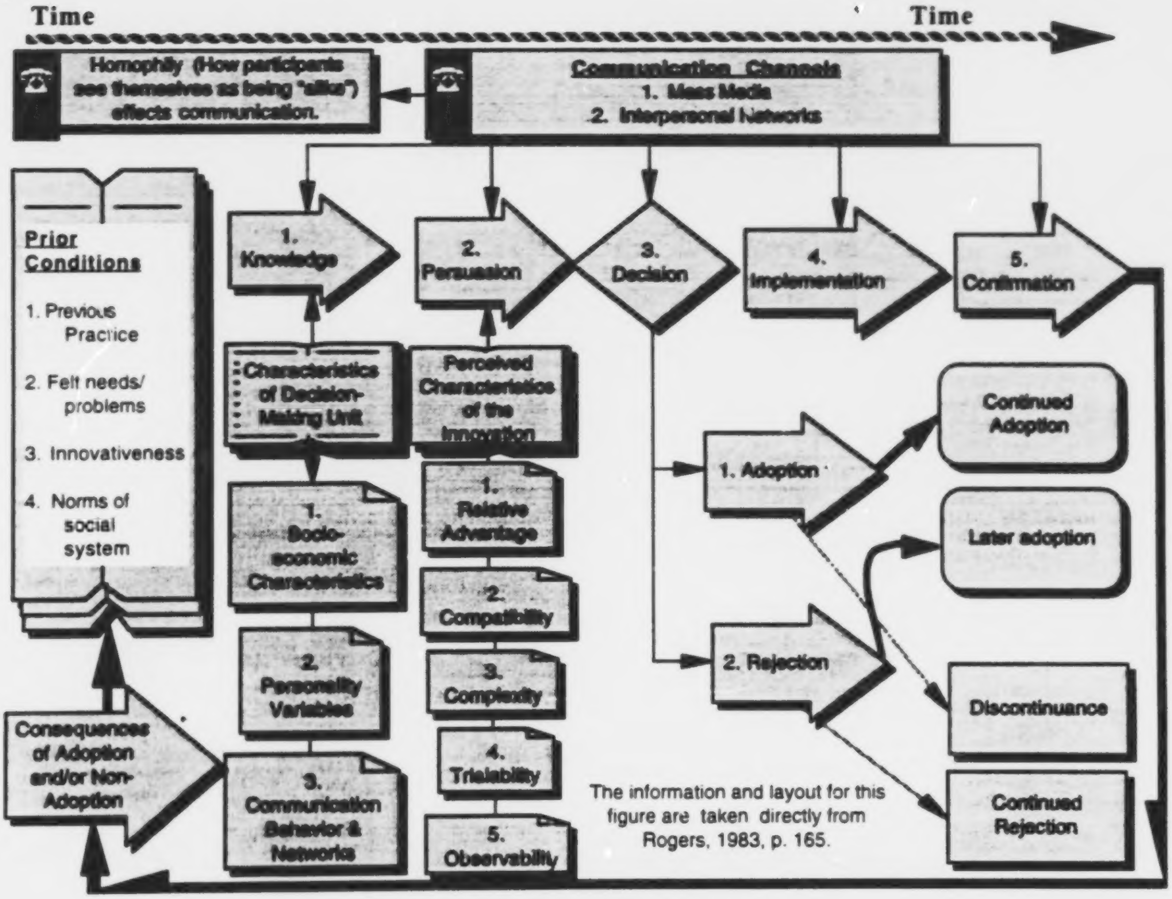
Time
Time
Homophily (How participants see themselves as being "alike") effects communication.
Communication Channels
1. Mass Media
2. Interpersonal Networks
Prior Conditions
1. Previous Practice
2. Felt needs/ problems
3. Innovativeness
4. Norms of social system
1. Knowledge
2. Persuasion
3. Decision
4. Implementation
5. Confirmation
Characteristics of Decision-Making Unit
Perceived Characteristics of the Innovation
1. Socio-economic Characteristics
2. Personality Variables
3. Communication Behavior & Networks
1. Relative Advantage
2. Compatibility
3. Complexity
4. Trialability
5. Observability
1. Adoption
2. Rejection
Continued Adoption
Later adoption
Discontinuance
Continued Rejection
Consequences of Adoption and/or Non-Adoption
The information and layout for this figure are taken directly from Rogers, 1983, p. 165.

Figure 1. Innovation-Decision Model.

Compatibility

1. Only the school of education cooperative learning specialist perceived that the adoption of this cluster of innovations had the potential to completely reengineer an instructor's curriculum and methodology. All other participant perceptions were mixed, as some had knowledge of at least one innovation but had only scant generalizations as to how any of the innovations were *compatible* with past practice.
2. The researchers also found that several of the participants, both university and school district, had gained considerable knowledge of some innovations from their spouses who were also K-12 teachers. This finding mirrors diffusion research findings that many potential adopters are influenced most by geographically near peers. Relatives are the most effective persuaders of all.

Complexity, Trialability, Observability

1. Analysis was impossible regarding the *technology cluster* as none of the participants understood the *technology cluster*.
2. None of the respondents understood the term, *multimedia*, and all perceived it as being very complex and difficult to "try." Some participants expressed feeling anxious about multimedia. Since all of the participants are over 40 years of age, one might predict a different reaction in younger faculty who typically have more exposure to the technology.
3. All participants perceived cooperative learning and process writing as "try-able" but very time consuming.
4. Both constructivist innovations had been in-serviced and used in the high school for over five years, yet the teacher had not made a decision to reject or adopt them prior to the study.

Innovation Characteristics Future Research

1. In attempting similar learning group innovation interventions, researchers/practitioners might benefit from pre-surveying perceived needs of potential adopters and providing respondents with that information. Diffusion researchers have concluded that potential adopters who can evaluate better their own needs can also better evaluate the match between new innovations (possible solutions) and needs/problems (Rogers, 1983, pp. 332-333).
2. Researchers and practitioners might also benefit from knowing to what extent misperceptions exist among teacher educators and K-12 teachers about technology nomenclature and what effect this may have on restructuring.
3. Educational innovation researchers may find value in studying the effect that spouses have on potential adopters' decisions.
4. Results from this study indicate that many dissemination agencies (regional education labs, state departments of education, intermediate educational service districts, associations, and vendors) provide awareness workshops to educators. However, *the real understanding and knowledge of "awareness work-shopped" educators may be minimal at best and even harmful at worst.* In addition, all study participants had knowledge of at least one innovation and believed it was a good thing to adopt, yet they still had not taken action to implement the innovation— in some cases for years. Future research might be profitable in evaluating effective ways to help educators move from *persuasion* to actual *implementation*.

Developing Effective Learning Communities

The study researchers needed more cognitive information of a philosophical and research nature in order to better ground the participants in the innovations. In the future, additional learning community activities will be more structured by the researchers.

Effective Learning Communities Future Research

Practitioners would certainly benefit from research on better ways to develop and grow successful learning communities and to know more about what might be termed a *cognitively-grounded facilitation approach to learning communities*.

Effective Interpersonal Communication Requires Intervention and Facilitation

Diffusion research studies have concluded that interpersonal communication with geographically near peers is particularly important during the persuasion stage (see Figure 1) of the *innovation-decision* process for most individuals in most social systems. Communication occurs most effectively when the receiver perceives the message sender as being like her/himself in such qualities as values, beliefs, education, knowledge, overt behavior, experience, social status, and so forth. This quality of "alikeness" is called *homophily*, and its presence is essential for many potential adopters for them to make an *innovation-decision*. Each social system has several categories of potential adopters, however, the early *majority* and *late majority* adopters require local *homophilious* persuasion communication (testimonials) in order to adopt. (Having geographically near *early adopter* who is conducting an observable test of the innovation may also be essential.)

The study results indicate that achieving *homophily* between higher education and K-12 faculty requires intervention by researcher/practitioners to facilitate this relationship and increase the probability of reaching some level of *homophily*. The researchers concluded that more social interaction and communication time should have occurred between the university and high school faculty to reduce the magnifying glass against the fishbowl effect of the first observation visit. Other studies indicate that these kinds of problems and lack of empathy and understanding are relatively common in higher education school district partnerships and specific strategies need to be developed to facilitate better communication (Danzberger, 1990; Knapczyk, 1991).

Time and geographic space are key variables

Numerous references were made in the study interviews, notes, and other information. The second university faculty visitation had to be postponed due to unanticipated additional time needed to inservice the high school teacher. Innovation research has identified that *potential adopter* communication time and *change agent* communication efforts are both directly related to the rate of adoption of an innovation. However, trying to increase communication time between the study participants has been difficult at best, especially given the three and a half hour driving time between sites.

Distance learning future research

The State of Iowa has installed a fiber optic communications network linking 115 sites. The university has an Iowa Cable Network classroom on campus, and the high school located over 200 miles away also has one in the local community college. The study researchers will be utilizing this two-way interactive video/audio communication network to enhance communication time and to provide a more structured approach to developing the learning community. The fiber optic network is seen as having the potential to reduce effects of distance and scarcity of time.

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THEORY

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Theory and Practice in ITTE

The use of information technology in education is often presented as an atheoretical activity–one that is not saddled with burdensome theoretical considerations. "Theory is fine in the ivory tower, but in the classroom it has little relevance," say some when asked about the theories underlying technology use in schools. The authors of papers in this section definitely do not buy that perspective. In forceful, if different ways, they make the point that technology use in schools is an intensely theoretical as well as practical activity.

Some of the papers deal directly with the implications of a particular theory or philosophy for technology and teacher education (Cafolla and Kauffman–information theory, Muffoletto–critical theory, Smith-Gratto–gestalt theory). James White's article does not adopt one theory but, instead, outlines five different conceptual foundations derived from curriculum theory and then relates those theories to technology. White's paper emphasizes the need to consider the conceptual framework embedded in different ways of using technology in schools. It brings to mind a sort of organizational *puzzle* that would involve trying to get teachers to use one form of technology in their classes. Suppose there were two options for using technology—one very behavioral and one very constructivist_and two teachers_one behavioral and one constructivist. Depending on the "match" between the teachers and the approaches you could end up with two happy teachers who eagerly adopt technology and use it effectively (within their conceptual frameworks) or two unhappy teachers who see technology as a problem.

Other papers in this section discuss the implications of an approach or perspective that is derived from theory (Cafolla and Kauffman–virtual reality, Kearsley–hypertext, Jinkerson–reflective thinking, Levine–learner assessment, Ayersman and Reed–knowledge assessment, Harlow, Maddux, and Johnson–world literacy). A few brave souls have even begun work on a metatheoretical framework for thinking about technology and teacher education. Maddux and his colleagues, for example, ask some cogent questions about how we move from potentially useful technology to technology that is actually being used in schools. Dale Howard's paper, and the paper written by Mike Waggoner, both build theoretical frameworks for thinking about instructional technology. Howard's framework is derived from phenomenology while Waggoner's has more of an organizational theory flavor to it.

Taken together these papers reflect the growing interest in theories as frameworks for both practice and analysis. They also reflect the fact that the field draws from a range of theories today, a sharp contrast to the situation just a decade or two ago when behavioral theories reigned supreme.

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Educational Computing: Avoiding the Everest Syndrome in the 21st Century

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In the past, we have written extensively about the importance of avoiding the *Everest Syndrome* in education (Maddux, Johnson, & Willis, 1992). As you might guess, the Everest Syndrome refers to the attitude among educators that we should use computers in education for the same reason that Hillary said he climbed Mount Everest - *because they are there.* We have suggested that this is a potentially destructive attitude because it focuses undue attention on questions about what the hardware and software can be made to do, and distracts us from asking questions about what we should be using computers to accomplish. In other words, the Everest Syndrome leads to questions about technology when professional educators should be asking questions about teaching and learning and the proper role of technology in these pursuits.

We have also suggested that the inappropriate emphasis on what computers can be made to do, and the lack of emphasis on how technology can empower students and teachers has been partially responsible for a backlash against educational computing. The backlash came as critics perceived that computers in schools were being used to accomplish relatively trivial goals. As we have said, "Since computers are expensive and require extensive time and effort to learn to use, their success depends heavily on our ability to find important rather than trivial goals to apply them to" (Maddux & Cummings, 1986, p. 34). Educators and policy makers are rightly reluctant to squander human and fiscal resources to accomplish trivial goals such as rote memorization of facts, mastery of motor skills such as typing, or other, low-level learning goals that could be accomplished through more economical means.

Another contributor to the backlash against educational computing is widespread extravagant claims made by computing advocates concerning the educational benefits of various computing applications. These claims, although well-intentioned, add impetus to the reaction against educational computing. By promising more than can be delivered, we set the stage for wholesale rejection when policy-makers and others realize that computers are not living up to our initial claims.

Only a few years ago, we considered this backlash to be so serious that it threatened the survival of educational computing, and we felt there was a danger that computers might be abandoned by most schools. We pointed out that:

> No one should doubt that educational computing could fail; the precedent for failure exists in abundance in the history of past efforts to integrate electronic technology and education. Eight- and 16-millimeter film, teaching machines, educational television, and numerous other electronic innovations have suffered from the well-known and dreaded pendulum effect in education. (Maddux, Johnson, & Willis, 1992)

(The pendulum effect is the tendency for an innovation in education to be the object of extravagant, unrealistically optimistic claims, followed by widespread disillusionment and eventual premature abandonment.)

Happily, we no longer believe that computers are in danger of being abandoned by teachers. While we were worrying about the dangers of pitching computing as a panacea for a host of real and perceived educational problems, computers continued to permeate the culture at large so completely that there is now no way to halt their entry into schools. In fact, we probably could not stop their entrance even if we tried!

Therefore, the good news is that computers in schools are here to stay. They have become an unstoppable force by virtue of their incredible ubiquity. Everywhere we look, we find computers! In fact, it has been true for several years that if one counts all microprocessors, there are many more computers than people in the U.S.! Virtually every business, small as well as large, uses computers. In addition, computers are turning up with increasing frequency in private homes, and a *Business Week* article in the November 22, 1993 issue reports that 31% of homes in the U.S. now have at least one personal computer. This article goes on to predict that half of all American homes will have computers by 1998. It therefore appears certain that computers will have a significant presence in the schools of the twenty-first century.

The virtual certainty of a future computer presence in schools should not lead us to complacency, however. Computers will be in schools, but the question is, will they *revolutionize* education?

We believe they have the potential to do so. However, they also have the potential to merely help us continue to do things that don't work very well. The choice will be made by the current generation of teachers-in-training, who will implement computers poorly or well.

This paper will focus on some of the issues that today's teachers-in-training will resolve in the future. The purpose of this discussion is to help clarify these issues for teacher educators, who must, in turn, help their students to think critically about these and many other issues, if the future of educational computing is to live up to its considerable potential.

The State of the Art in Educational Computing

We consider ourselves optimists with regard to the potential benefits of computers in education. Although we believe that computers are often being poorly implemented in education, we cannot agree with Donald Ely (1993), the Associate Director of the ERIC Clearinghouse on Information Technology. Ely contributed an article to a special issue of *Educational Technology* devoted to international perspectives on the impact of computing in education. The issue was intended to be a "'snapshot album' of the progress being made around the world in realizing the potential of educational computing" (Cavalier, & Reeves, 1993, p. 8). Ely's article was the one devoted to educational computing in the United States. Here is his conclusion:

> . . .The results of research on student learning show, in most cases, no significant difference between learning through computer-based instruction and traditional teaching. . . . On a national scale, one would have to conclude that computer-based instruction in U.S. schools and universities has had minimal impact. By any measure . . . the conclusion is 'little or no effect.' (Ely, 1993, p. 55)

Ely bases this pessimistic conclusion on the results of research studies of the efficacy of educational computing. On the surface, his pessimism is justified. However, we believe the lack of significant findings in this research is due primarily to problems of research methodology, rather than to a lack of beneficial effect. We have addressed the problems with this research elsewhere (Maddux, 1993), and a full treatment of this topic is beyond the scope of the present article. Suffice it to say that entirely too much of the efficacy research is based on the simplistic idea that *mere exposure to computers will be beneficial to teachers or learners*. Actually, one of the things we have learned from the early research in educational computing is that mere exposure to computers is no more beneficial than is exposure to a teacher, a book, or to anything else. It should go without saying that the critical element is not the presence or absence of a computer, but *the way the computer is employed in the teaching/learning process*. The majority of efficacy research pits teaching and/or learning with a computer against a vague, seldom-defined or poorly-defined construct called *traditional teaching or learning*.

It is understandable that research findings from studies employing this methodology often fail to find an advantage for the computer-using groups. For example, would any reasonable person expect to find that using a computer poorly is preferable to good, "traditional" teaching or learning? Then too, this research literature frequently ignores critical teaching/learning variables. The research on word processing is a good case in point. Early research failed to find evidence of a positive effect on the quality of students' writing. However, much of this early research ignored student variables such as (a) writing proficiency at the beginning of the study, (b) subjects' mastery of word processing skills, (c) presence or absence of a disability, (d) type of word processing program learned, etc. Research in this area is improving in quality, and more recent studies are beginning to demonstrate that, under the proper conditions (the appropriate technology used in combination with the appropriate instruction for the appropriate students), word processing can have a beneficial effect on the quality of writing.

About the only thing we learned from much of the early research is that the computer is *not* such a powerful learning or teaching tool that it is effective when used with any kind of software, with any and all types of students, using any instructional techniques.

Computers and Megachange

Megachange is Seymour Papert's (1993) term for his ideas about what needs to take place in schools, and it is the central thesis of his latest book, *The Children's Machine*. This book is attracting a great deal of attention in educational circles. However, we are less than impressed. Although we believe that Papert is one of the most positively influential figures in modern educational technology, we believe that this book is a pale shadow of Mindstorms (Papert, 1980), his revolutionary first book.

The new book has some of the same incisive brilliance as the first one. However, the first fifty pages or so are almost incredibly naive. Papert misses the mark, in our opinion, because he has yielded to a common temptation of those who achieve great success and wide acclaim - the temptation to dabble in matters outside of one's true area of expertise.

Unlike *Mindstorms*, which was a book about children and computers and how they could be brought together to facilitate learning, *The Children's Machine* is a book about public school reform in the United States. (In fact, the subtitle of the book is *Rethinking School in the Age of the Computer.*)

While Papert's credentials to address computers and children's thought processes are unique in their excellence (as nearly everyone knows, he studied for years with Jean Piaget), the same cannot be said for his knowledge about American public schools, and the essentially political nature of educational policy-making and educational change.

Perhaps this is true because Papert himself never attended school in this country. Instead, he went to school in Africa. Judging from his suggestions about school reform, we do not think that he has a realistic grasp of the problems faced by many public schools in this country. His vision of millions of children across the country "cooperating joyfully" (Papert, 1993, p. 25) in the gathering of data on acid rain does not square with our own experience teaching in an inner city school.

Papert's premise is that schools must involve children in something they see as important. We agree. However, when children don't have enough to eat, or when they fear for their own personal safety at home and at school, it is unlikely that they will believe that gathering data on acid rain is *doing something important.* We believe that Papert's ideas about school reform suffer from the same problem we see in the reform suggestions of many politicians and business leaders - they are based on the mistaken assumption that basic, important changes in schools can take place in the absence of basic, important changes in the culture at large.

Therefore, we think the first 50 pages or so of *The Children's Machine*, which deal mostly with school reform, has very little of value to say to us. Many of Papert's ideas may be quite workable in expensive private schools, or even in affluent, middle-class public schools. However, educational computing must be brought to all students in all schools, and schools in our country are increasingly serving large numbers of poor, highly diverse student bodies. We should make the use of computers in poor, highly diverse schools a high research and development priority.

Interactive Multimedia

The newest computer application to be heralded as an educational panacea is *interactive multimedia*, or *hypermedia*. The two terms are often erroneously use as synonyms. However, most of the excitement seems to be directed toward what is actually hypermedia. Such lessons usually, although not always, involve computers and other media, and permit users to create their own paths through the material to be learned.

We agree that there is great potential for the use of hypermedia in education. However, we believe that the gap between educational potential and current reality is light years wide. One of the prevalent arguments is that the use of hypermedia is more consistent with the way people think than is the use of traditional media such as books. This argument suggests that books lend themselves to linear, sequential thinking, while interactive multimedia promotes the user to explore the material in a non-linear, idiosyncratic fashion.

Is this really more consistent with the way children think and learn? Is there evidence that such is the case? If children really do learn more efficiently in non-linear fashion, we strongly suspect that there are many critical learner and teacher variables that must be taken into consideration. For example, it may be that beginning learners learn simple material more efficiently in a linear fashion, while advanced learners profit more from hypermedia approaches to complex, ill-defined material (Spiro, & Jehng, 1990). In any case, the state of the art in research on this topic is in its infancy, and we should not jump to the conclusion that non-linear learning is best for everyone, in every subject, at every age. (A landmark seminal publication in this area is *Cognition, Education, Multimedia*, by Nix and Spiro (1990).)

In addition, if hypermedia is to become a major learning tool in schools, there must be a revision of the way we think about teaching and learning. The use of hypermedia is an individual, rather than a group activity. If it is to be more than a useful reference tool, we will have to bring about radical changes in school. Learning will have to become more individualized.

In addition, good hypermedia lessons are scarce, and teachers do not have the time or expertise to create their own. Therefore, wide implementation will have to wait for the production of a large library of commercial packages spanning many disciplines.

Then too, the installed base of hardware in schools is currently much too crude to accommodate sophisticated hypermedia and multimedia lessons. For example, Ely (1993) suggests that:

> Apple II operating system computers are found in 61% of the schools; MS-DOS in 24% of the schools; Radio Shack in 4%; and Commodore in 4%. Macintosh operating systems are found in 4% of the schools. (p. 53)

Yet another problem is that the vast majority of schools do not have anywhere near enough computers to permit wide use of hypermedia. In fact, Ely (1993) goes on to report that fully one third of schools in the U.S. still have more than 45 students for each computer, while only 10% have 1 to 9 students per computer.

Another problem is that hardware and software configuration can be extremely complex and time-consuming, even for those teachers with considerable technical expertise. Hypermedia and multimedia must be made much more user-friendly before wide use will be practical.

So long as the above problems are widespread, it will not be possible to bring hypermedia to more than a handful of public school students.

Inservice and Preservice Training

This may be the most important topic of all. In 1988, the Office of Technology Assessment produced a report called *Power On* (1988), in which they reported that training was a major impediment to the computer achieving its educational potential. The OTA is finishing up some new research, and the preliminary results are equally discouraging.

They say that:

1. spending for inservice training has not kept up with spending for hardware and software,
2. teachers continue to be poorly prepared to teach with technology,
3. teachers-in-training see very little technology used in their student teaching placements,
4. teachers-in-training seldom see their education professors using technology in teaching,
5. faculty members in colleges of education don't have the skills needed to use technology in teacher training,
6. there is a shortage of technology available in colleges of education,
7. there is a critical shortage of technology inservice for faculty in colleges of education. (NEAB, 1993)

We believe that curriculum integration in public schools and in colleges of education is essential if we are to continue to make progress. Teachers must stop relying only on computer labs and start using technology in their rooms, and education faculty must do the same thing. If technology remains the exclusive province of one or two technology experts in the college, then it will never achieve the status of an important teaching and learning tool in teacher training or in public schools.

Conclusion

We began this paper with a pessimistic quote from the *Educational Technology* special issue on the worldwide status of educational computing. We would like to end it with several more optimistic quotations. Cavalier and Reeves (1993), in summing up the entire issue, suggest that "Dedicated efforts with limited hardware have produced heroic results" (p. 8). They were speaking of efforts in other countries, but we believe the same can be said of educational computing efforts in this country. Considering the lack of sophisticated hardware and the state of research in educational computing, practitioners have produced heroic results. Research may not often show the true outcomes, but we know there are places where these heroic efforts are paying off. Ely (1993) sums up our feelings in another quotation:

> Where deliberate efforts have been made by individual teachers or by entire institutions one would have to say that, in those circumstances, the teachers and learners will never be the same again. They have gained new skills, new perceptions of how to learn, increased motivation, and renewed enthusiasm for teaching and learning. (p. 55)

Although Cavalier and Reeves (1993) come to the pessimistic conclusion that the goal of using computers to improve the welfare of children is little realized in the poorest or the wealthiest countries in the world, they go on to sum up the motives of those of us who continue to be interested in computer education. They say that despite the overwhelming barriers "The dream of improving the lives of children by providing them with the power to compute persists" (p. 7)

It is that dream that unites us, and so long as we keep that goal in mind, we are confident we will eventually succeed in achieving it.

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Information Theory: A Quantitative Approach to Instruction

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In this paper, we present a brief introduction to information theory and its mathematical tools. Also presented is a mathematical procedure that provides the educational researcher and/or instructional software developer with the means to quantify the amount of information held in specific textual material for any individual learner.

The importance of information theory, as it relates to education, is embodied in the idea that while the initial value of all information is absolute, its received value is relative to the internal state of the learner. That is, the information content is unique to each learner. If we view the instructional process as the transference of information from a transmitter (teacher, book, video, computer, etc.) to a receiver (learner), we can use the tools derived from information theory to quantify the value of the information as it relates to each learner. Thus, procedures derived from information theory have value in developing individualized, intelligent, instructional systems by providing educators with a tool to quantify the value of meaningful information as it pertains to individual learners. It gives us one more tool to help the transition of formal education from a group experience to an individualized event.

Background

Information theory has its roots in the derivation of methods and procedures for the transference of information via electrical means. The father of information theory, Claude Shannon, established the field when he formulated the fundamental laws of information theory. Shannon (1948, 1951) places information among the basic constituents of the universe. Information is, in fact, measured as negative entropy. Entropy in the physical world is defined by the American Heritage Dictionary (1992) as "A measure of the disorder or randomness in a closed system" or in terms of information theory as "A measure of the loss of information in a transmitted message."

Many other related definitions of information are given in the literature (see, for example, Singh,1966; Edwards,1964; Khinchin, 1957; Ash, 1965; Fuchs, 1971; Frank, 1962; Guilbaud, 1959). But the definition that is most appropriate for this paper is the definition given by Shannon and Weaver (1969) where they say "Information is a measure of one's freedom of choice when one selects a message." This conveniently ties the definition of information and its measurement directly together providing educators with the mathematical tools and experimental procedures to accurately measure the information content of a received informational message by a learner.

If we were to present a map of the moon to a learner who knew nothing about the moon, the information content of this map would be maximum for the learner. On the other hand, if we were to present the same map to a moon geographer, he would he would already know the information on the map. To the moon geographer, the map contains no new information. The information content for the moon geographer is thus zero. Here we have the case where the transmitted information (the map) is the same to both but the received value is different. This difference is due to the internal condition of the receiver. We call this received information subjective information. That is, the received information depends upon the internal (subjective) state of the receiver, and it differs from one learner to the next. Thus each and every learner has a different subjective state when presented with information. Our problem then becomes one of attempting to determine this unique subjective state of each and every learner. As such, we are concerned with answering two questions in this paper: What is information? And how can we measure information?

Instruction-Learning Process

When we describe the instruction-learning process, we are essentially describing a communication system. Instruction and learning are two vital aspects of the educational process that depend upon the manipulation of three activities: the input of meaningful information, the processing of this information, and the output of meaningful information. Because instruction is concerned with the transference of information and learning is the act of or the result of the information transfer, when we speak of an instruction-learning system we are describing a communication system. Typically a communication system consists of the components and processes as shown in Figure 1 (Shannon and Weaver, 1969):

- Information Source: The mechanism that selects a desired message out of a set of possible messages.
- Transmitter: Encodes the desired message into a signal.
- Channel: The medium through which the signal is transmitted.
- Receiver: Accepts and decodes the transmitted signal into the message.
- Destination: Interprets the message.
- Noise: Unwanted additions imposed upon the message. These additions can be either from an external source, an internal source or combinations of the two. The effect of noise is to change the meaning of the message.

The information source and transmitter represent the teaching system, whether it be a live teacher, book, video, computer or any other means of presenting information. The receiver/destination is, of course, the learner. In between the information source/transmitter and the receiver/destination is the channel (medium) through which the information flows. Imposed on all components of the system is noise. Noise is an important feature because it can occur at any location within the system. Two types of noise are identified - external and internal. External noise is produced by outside influences that decrease both the value and amount of usable information. We are all familiar with the noisy classroom, the neighbor's stereo, food odors from the kitchen, telephones and a host of other external sights, sounds, and sensations that have an effect upon both the transmission and reception of the message. Internal noise occurs from within the system itself. Most notably internal noise is caused by feelings, emotions, pain, drugs, illness, worries, frustrations and so forth. Noise is such an important factor in an instructional-learning system that we might couch learning and even intelligence in terms of the amount of noise reduction we are able to produce in a human system.

Concepts of Information Theory

Based upon the communication system shown in Figure 1, we can consider that messages are transmitted through the system as a sequence of signals. The signals are embodied in physical quanta, measurable phenomenon such as light, electronic pulses, dots on a paper arranged as a picture, printed images which we recognize as letters, materials that

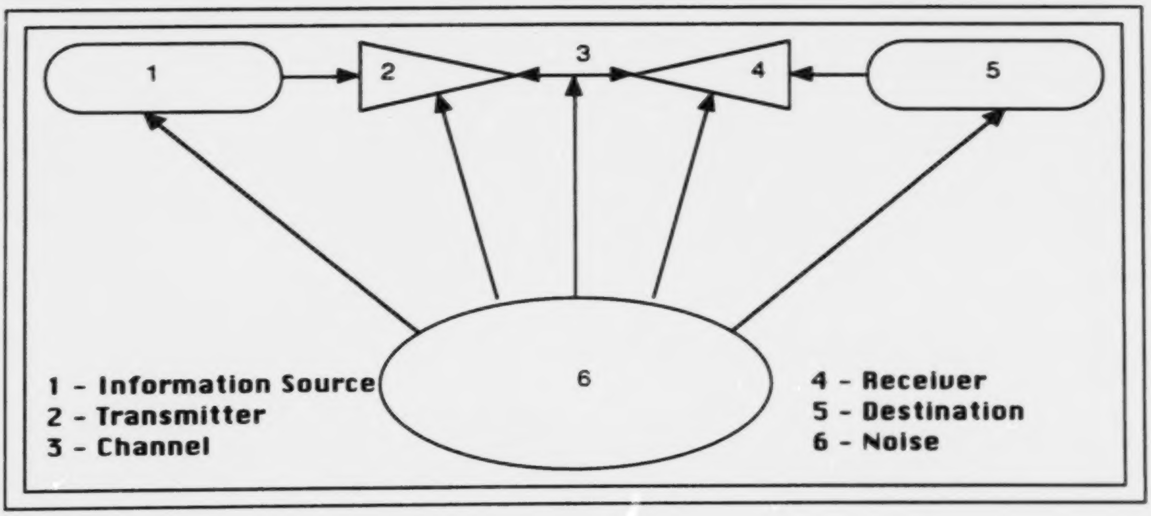

Figure 1. Communication System

reflect various frequencies of light that result in color and so on. These physical quanta have no value or meaning in themselves. When the signals take on meaning, we call them signs. When we group certain of these signs into meaningful ensembles, or a set of signs, they then become letters of the alphabet, words in a language, and pictures in a story. Signs grouped together in ensembles are called messages.

The more unexpected a message is the more subjective information it contains. An unexpected message has a high information content. To our learner studying the moon map, the signs making up the map are almost totally unexpected because he has never seen them before in the given context. On the other hand, if the message is expected, we say the information content is low or, more precisely, it approaches zero. In other words information is a measure of the uncertainty of a sign. The more uncertain the sign is, the higher its information content.

Consider a simple two person game. Given the numbers 1, 2, 3, 4, 5, 6, 7, 8 one person selects a number and doesn't tell the other. The second person tries to guess which number has been picked, by asking a question. The objective is to guess the number with the fewest possible tries. There are several methods the guessing person might use. First, he could start with 1 and guess every number in sequence until the correct number was guessed. The best situation would occur if the first guess were right, in which case the guesser would have to ask only one question. The worst case would occur if 8 were the selected number with the guesser asking seven questions. On the average we would expect to achieve the correct answer in four guesses.

A second method might be to guess the numbers at random. Again the best we could hope for would be one guess, and the worst seven guesses. As in the previous strategy we would expect, on the average, to achieve the correct answer in four guesses.

A third method is to divide the group of numbers in half and ask if the correct number is less than 5. Asking if the selected number is greater than 4 would yield an identical result. Let us say that the selected number is 2. The second person begins by asking , "Is the selected number greater than 4?" The answer given is "No." This tells the second person that the number is either 1, 2, 3, or 4. Dividing this group in half, he asks, "Is the selected number less than 3?" The answer is "Yes." With the last question being, "Is the number less than 2?" the selected number is correctly guessed. In this case it takes, on the average, only three questions to determine the correct answer, a noticeable improvement over the previous strategies. In fact, it has been shown that the optimum guessing strategy is to use this type of halving procedure. This will in all cases result in the fewest possible questions or guesses.

Now, let us double the size of the ensemble from eight to sixteen numbers. How many guesses would it take to determine the selected number? It would take four guesses to arrive at the answer. Although we have doubled the size of the ensemble of signs, we only need one more guess to determine the correct answer.

This demonstrates that a relationship exists between the size of the ensemble and the amount of uncertainty (information) associated with it. From this we now need to state this relationship in terms of a formula which we can use for any ensemble size. Table 1 shows the ensemble size vs. the number of questions required to guarantee a correct answer. The ensemble size is denoted by N and the uncertainty of the ensemble is represented by H

Table 1
Ensemble Size

Ensemble Size (N)	Questions Asked (H)
1	0
2	1
4	2
8	3
16	4
32	5

The relationship between ensemble size (n) and the number of questions asked (H) is expressed by:

(1) $$N=2^H$$

Changing equation (1) to represent the degree of uncertainty contained in the ensemble, which is our measure of units of information per sign of the ensemble, is:

(2) $$H=\log_2 N$$

To summarize, if we have an specific ensemble of 8 signs from which to choose, we have $\log_2 8 = 3$ bits of information. If we have an ensemble of 32 signs, we have $\log_2 32 = 5$ bits of information.

Shannon's Guessing Procedure

The key to the above discussion is that each sign has an equal probable chance of being accepted. However, this is not the case for the English language or any language or any other form of meaningful, information representation. The English language is comprised of words (letters, signs) that are arranged into stochastic ensembles. Because of this stochastic dependency, the measurement of the amount of information contained in a specific text cannot be accomplished by using a simple equation such as given in equation (2). Fortunately, Claude Shannon (1951) derived a guessing procedure for analyzing the syntactical information content of meaningful texts. As such, his guessing procedure provides us with the ability to calculate the subjective information for any text for any specific learner.

Shannon's procedure requires the learner to guess the letters of an ensemble letter by letter. After each guess, the learner is told whether he is correct or not. If incorrect, the learner guesses again until he guesses the correct letter, each

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time receiving feedback as to the correctness of the choice. If the learner is correct, he moves on to the next letter and repeats the process. The number of guesses required for each letter are tabulated. Consider the following trivial example:

Ensemble:	Swiss	Cheese	Has	Holes
Number of guesses:	85241 1	732111 1	411 1	32111

The phrase is part of an instructional program that teaches about cheese. At this juncture in the program the learner is asked to guess the sequence of the ensemble letter by letter according to Shannon's procedure. The first letter S takes the learner 8 tries before he is correct, the second letter **W** takes 5 guesses and so on until the phrase is completed. Notice that when the learner has an idea of what the word is, for example cheese, after guessing the first three letters it only takes him one guess to get the next letter and one each for the remaining two letters. The uncertainty is reduced to zero and thus these signs contain no subjective information for the learner.

From the number of guesses, it is quite easy to determine the numerical value of the information content of the ensemble. We do this by adding the information value of the signs as determined by Equation (2) such that the information, measured in bits, of the given ensemble of length N=22 is:

$$\begin{aligned} H(\text{Ensemble}) = {} & \log_2 8 + \log_2 5 + \log_2 2 + \log_2 4 + \log_2 1 + \\ & \log_2 1 + \log_2 7 + \log_2 3 + \log_2 2 + \log_2 1 + \log_2 1 + \log_2 1 + \\ & \log_2 1 \ \log_2 4 + \log_2 1 + \log_2 1 + \log_2 1 + \\ & \log_2 3 + \log_2 2 + \log_2 1 + \log_2 1 + \log_2 1. \end{aligned}$$

$$\begin{aligned} = {} & 3.00 + 2.32 + 1.00 + 2.00 + 0.00 + 0.00 + \\ & 2.81 + 1.58 + 1.00 + 0.00 + 0.00 + 0.00 + 0.00 + \\ & 2.00 + 0.00 + 0.00 + 0.00 + \\ & 1.58 + 1.00 + 0.00 + 0.00 + 0.00. \end{aligned}$$

$$= 18.29 \text{ bits}$$

The next step is to divide H(Ensemble) by the number of signs (N) in the ensemble. Here we have 22 signs including the spaces between the words. This results in:

$$(3) \quad H(\text{Ensemble})/N = 18.29/22 = .83 \text{ bits/sign},$$

which is a quantified value of the information content of the message for our hypothetical learner. If another learner had made the guesses, the number would be higher or lower depending upon what the learner knew.

Shannon (1951) derived a less trivial but more elegant formula for the guessing procedure. It has been shown by Frank (1962) to be a more accurate method than the simple addition method above. It is equation (4) below:

$$(4) \quad (\text{Ensemble}) = \sum Nr\,(r \ ld(r) - (r-1)\ ld(r-1))$$

where: Nr=Absolute frequency which the number r occurs in the guessing sequence of N numbers.

ld = logarithm to the base 2: ($\log_2 r$).

This procedure can be implemented in a computer assisted instructional program or it can be used as a research tool in determining the subjective information content of various materials. It should be pointed out that the above procedure can be also be used for guessing syllables, and for guessing words as well as individual letters as shown above. The results will be equivalent.

Experimental Models

As an example, one might be interested in determining the amount of subjective information contain in a text for a group of learners as a function of age, or in a specific subject matter area. A typical situation would be to present to the learner an instructional sequence of information rich material - that is, new information that the learner is expected to learn. Using the computer as a CAI presentation device, the learner is presented with the information to be learned. The learner begins by reading part of the text. After several phrases or sentences, he is required to guess letter by the letter the next six or so words. This procedure is repeated several times until a reasonable sample of text has been presented. The number of wrongly guessed signs (letters or words) is accumulated by the computer software and used as the data for formula (4). The guessing sequences may be preselected or selected at random by the program. The information to be collected for each learner is:

a. The total length of the text of the guessing sequences.
b. The number of guesses for each sign (letter or word).

This information is then entered into a subroutine that calculates the information content of the presented passage for each learner. This information can then be used to determine the next instructional sequence for the learner. If the information content is high, a representation of the material at a lower level might be considered. If the information content is low, then the learner should be moved forward to a higher level of information. Other variants of this procedure may be used based upon the researcher's goals.

An actual experimental study that used the guessing procedure to empirically derive the subjective information for the English language was done by Kauffman, Johnson and Knight (1976). Learners were presented with textual material relevant to the academic subject of information science and news of the day. Using equation (4) to begin with, the empirically derived equation is:

$$(5) \quad H(\text{text})_E = 0.031X - 0.031$$

Where H(text)E = Subjective Information per Text.

X = Percentage of incorrectly guessed signs.

This simplifies to (See derivation in Kauffman, et al., 1976):

(6) $I = 3.1E$

Where: I = the information in bits

E = the numbers of errors.

Thus one can determine the subjective information content of a particular text by multiplying the number of errors made in a guessing procedure by the constant 3.1.

It is interesting to note that a similar equation was derived by Weltner (1973) for the German language. It is:

(7) $H(\text{text})g = 0.039X - 0.080$
Where: $H(\text{text})E$ = Subjective Information per Text.

X = Percentage of incorrectly guessed signs.

As can be seen, the German and English equations are remarkably similar. This serves to confirm the validity of the derived equations. However, because these equations were empirically derived, they are dependent upon the time in which they were derived. Thus, we would challenge the reader to redo the experimental derivation, particularly for the English language. Additionally, equations should be derived for Spanish and other languages used in our schools.

Conclusion

The guessing procedure presented is a means to quantify the information content of specific textual information for any given learner. Because the information varies from learner, this procedure allows a direct evaluation of the *meaningfulness* of any presented textual instructional material relative to the internal state of the learner. We have always known that the internal state of the learner is directly related to his ability to process information in a meaningful manner. We also know that certain subject matter is more difficult than other subject matter independent of the learner. These two factors, the internal state of learner and the inherent difficulty factor of the material, are variables that directly affect the efficiency and effectiveness of the instruction-learning process. The information based procedure outlined in this paper provides a direct means to quantify these two variables with one measure. This allows the educational researcher and/or instructional software developer to build into systems of instruction, a quantifying measure of the effectiveness of instruction.

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The Discourse of Change: Technology and School Reform

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Technology and school reform is foremost about education, the education of children who have real lives to live and the about teachers and administrators who live and work daily in a place called school. School reform and technology is about parents, communities, and business. It is also about symbols, illusions, dreams, fears, and hopes. Education as a social institution is about all of the these and none of these. Most of all it is about power, language, and human interest.

Constructing and re-constructing social institutions is a social process. Schooling in the United States serves a social purpose which is reflected in the symbolic and institutional interactions, regulations, and controls over what teachers, administrators, students do and think. Over the last ninety years the use of various technological systems have played a major role in both educational as well as business practices. The purpose of this essay is to suggest that a re-contextualizing of the current efforts in school restructuring, one which is historical and social, will yield a different agenda, and a different discourse from the current one on technology, schooling, and change.

Currently two dominate discourses on technology exist in education. The first, which is usually openly embraced as progressive and innovative, is what I refer to as "Fox Fire Technology." By this I mean the vision of technology as a device that is used in a humanistic, democratic, learner centered environment, controlled by students and teachers. For example, schools using the Internet to connect teachers and students from local and romote sites may promote thinking about the world as a global interdependent community where meaningful exchange of ideas, experiences, and information can occur. It is a reflective pedagogy concerned not only with developing communication skills, but for what is being communicated. Finally, a Fox Fire Technology which values student's voices, the democratic process, and social equality, is an ideological discourse situated within a continuous struggle over different ways of knowing, being and acting.

The second discourse on technology in education centers on systems of control. It is a system which is designed to control experiences, evaluation, dissemination and delivery of curriculum. In a very real sense it, the technology of instruction, becomes the curriculum. Form becomes content. A technology of instruction is a style of thought situated in logical positivism (Feenberg, 1991; Mannheim, 1952; Muffoletto, 1991, 1993; Postman, 1992). It is a technological discourse which has given education programmed instruction, outcome-based education, and the belief that measurable, regulated, and generalizable experiences begin to define and correspond to excellence. A technology of instruction is a systematic control of educational experiences, their development and their delivery. Technology in this form values educational engineers over autonomous teachers (Heinich, 1985). It is a ideological discourse situated within a social world that needs to control in order to perceive benefit.

This essay addresses the second discourse, a technology of systems, control, and benefit. I believe the Fox Fire

X = Percentage of incorrectly guessed signs.

This simplifies to (See derivation in Kauffman, et al., 1976):

(6) $I = 3.1E$

Where: I = the information in bits

E = the numbers of errors.

Thus one can determine the subjective information content of a particular text by multiplying the number of errors made in a guessing procedure by the constant 3.1.

It is interesting to note that a similar equation was derived by Weltner (1973) for the German language. It is:

(7) $H(\text{text})g = 0.039X - 0.080$
Where: $H(\text{text})E$ = Subjective Information per Text.

X = Percentage of incorrectly guessed signs.

As can be seen, the German and English equations are remarkably similar. This serves to confirm the validity of the derived equations. However, because these equations were empirically derived, they are dependent upon the time in which they were derived. Thus, we would challenge the reader to redo the experimental derivation, particularly for the English language. Additionally, equations should be derived for Spanish and other languages used in our schools.

Conclusion

The guessing procedure presented is a means to quantify the information content of specific textual information for any given learner. Because the information varies from learner, this procedure allows a direct evaluation of the *meaningfulness* of any presented textual instructional material relative to the internal state of the learner. We have always known that the internal state of the learner is directly related to his ability to process information in a meaningful manner. We also know that certain subject matter is more difficult than other subject matter independent of the learner. These two factors, the internal state of learner and the inherent difficulty factor of the material, are variables that directly affect the efficiency and effectiveness of the instruction-learning process. The information based procedure outlined in this paper provides a direct means to quantify these two variables with one measure. This allows the educational researcher and/or instructional software developer to build into systems of instruction, a quantifying measure of the effectiveness of instruction.

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Technology vision to be an illusionary discourse, one used to camouflage the real power relationships in the current debate over educational reform. It is a discourse that gains it strength from the illusive ideological "we."

The history of American education has centered around issues of control. Struggles and conflicts between opposing philosophical, economic, and political interest have provided the tapestry and the binding of American education (Kliebard, 1987, 1992). The school curriculum, as a selected, organized, and delivered body of knowledge, has been the focus of much debate throughout our history. The curriculum, the "stuff" that teachers and educational media deliver to children, as well as adults, not only provides the material of thought, but also the structure or "style of thought" itself (Mannheim, 1952; Salomon, 1979). The school curriculum and its delivery has attempted to control what teachers and students experience.

The curriculum effects "what" we think about as much as "how" we think about it (Apple, 1982, 1993; Goodman, 1978; Popkewitz, 1991). How we think about what we think has been the concern of dominate ideologies as well as those marginalized and struggling. Public education, as a social institution, has historically reflected the dominate "ways of knowing." The contemporary school and its modern day curriculum, caught up in the debate on change, reform, restructuring and technology, reflect not only visions, wishes, and concerns, but the interests of those who control the discourse; what is said, who hears it, and who is allowed to say it (Apple, 1979; Cherryholmes, 1988). The same may be said about the current interest in computer related hardware and software. How and why computers are integrated into the daily life of the school may point more accurately to issues related to the control of knowledge and the work of teachers at the expense of democratic practices.

Technology is not a collection of neutral devices or machines. As a system, as a science, as a "manner or style" of thinking about phenomenon, technology is not neutral (Feenberg, 1991; Mumford, 1934; McLuhan, 1964; Postman, 1992). As a style of thought technology defines its own way of thinking and speaking about reality and possible actions within it (Mannheim, 1952). Machines, tools, and their uses are not value free, they embody the culture of their time and the interest they serve. Technology as a way of thinking and as a manner of behavior is a social construct grounded in logical positivism, social control, and system management. (Postman, 1992; Salomon, 1979).

From the tic of the first clock, which constructed and defined notions of time and behavior, to the expert system embodied within computer software and hardware, control by the system and the illusive ideological "we" behind it, has provided the fundamental thought steering technology (Garson, 1988; Muffoletto, 1993) and our understanding of ourselves and social reality (Rorty, 1991).

Technology and school restructuring is not simply a manner of injecting various computer hardware and related software into the practices of teachers. Technology as a manner of thinking and acting values particular ways of knowing. Any change to social institutions creates new horizons, new possibilities, and an extended language through which to think about and legitimate the change itself. Change as a social act benefits some and not others. If technology, like society, is a social construct (Berger & Luckmann, 1966), questions must emerge addressing who benefits from change, what is lost and what is gained. To consider then, the relationship between technology and school reform as a discourse of change, is no simple matter. Any discussion of change must be considered in light of history and interest (Harbermas, 1968). The justifications, the visions, and the benefits of change are situated within that history, as a discourse of progress and innovation (Besser, 1993).

Changes in educational horizons, polices, practices, and ways of knowing, have been seen as solutions to problems or gaps in the educational process. As Larry Cuban (1990) has noted, these problems are actually conflicts over values "that surface frequently as school issues get dealt with as a series of reforms in structures, rules, staffing, and programs" (p. 329). Change as a result of policy shifts and new methods of instruction all too often have been termed as innovative and have included within it's discourse notions of progress as a technology of instruction and management (Callahan, 1962; Kliebard, 1987; Saettler, 1968). Which is simply restated as a discourse of control.

Even though the discourse on educational reform has tried to clarify the social problems that were to be confronted by the American public school, the dominate public discourse has been reduced to a series of slogans and generalities. The meanings of which are vague, situational, historical, and political. Generalities and slogans like "excellence in education", "global economics and international competition", "community interest and control", "life time learners", and "students as contributing citizens and family members", emerge out of the discourses made by special interest groups for political efficiency. Solutions to such problems as dropping test scores, poorly or under prepared workers for a changing working environment, and a resistant and poorly educated teaching population, are articulated in terms of the scientific management of instructional and learning experiences; a technology of instruction and institutional control. Simply put, it is a style of thought which requires more control over the content, procedure, and evaluation of educational experiences.

Though most reform literature refers to the social enhancement of human beings, the real benefit appears to be directed at needs of business and our national interest to compete on a global scale. For example, found in the *SCANS REPORT* (Department of Labor, 1991) are discourses referring to progress, individuality, and productivity. General positions taken within the report calls for the following: "All American high school students must develop a new set of competencies and foundation skills if they are to enjoy a productive, full, and satisfying life. . . The qualities of high performance that today characterize our most competitive companies must become the standard for the vast majority of our companies. . . [and] . . . The nation's schools must be transformed into high-performance organizations in their own right." (p. vi) It appears that the authors of the *SCANS REPORT* envision a full and satisfying life brought about by high performance competitive standards. We are told that in order to achieve that vision and quality of life American education should model the high productive standards and the institutional culture of successful business. Theses are same businesses that are striving to further regulate and organize the labor of blue and white collar workers inside and outside our national boundaries (Garson, 1988).

High performance industries need to control the production process, the worker on the line or in the office. A basic and historical miss-trust of the employee has led to the increased need to control the labor process and product outcomes. Through the development of advanced Tayloresque "expert systems" the experiences and skills of managers to front-line service workers are being systematized and controlled (Garson, 1988). In education, curriculum design teams developed performance objectives, teacher-safe materials, and standardized methods and evaluations. Under the guise of national standards and evaluations the issue of control over the curriculum, its delivery, and its evaluation is paramount. Portfolios, which were initially viewed as a reply to the standardized and regulated student evaluation process, are not immune from attempts to regulate and control how they are understood and used on a functional and symbolic level. In an effort to control the process, the qualitative nature of portfolios is being quantified and standardized.

Like business, education strives to replace outdated techniques, inefficient methods, and lazy or unproductive workers (teachers). In controlling the outcome expectations for students, the system controls the form and process of the curriculum. As long as scores provide the measure for the effectiveness and quality of our schools, and the ability of teachers to teach, teachers will teach to the pre-determined outcomes.

High production standards, efficiency, productivity, and control over the learning and teaching environment are off shoots of the human engineering movement which has been promoted as being successful in industrial and post-industrial industries. Popkewitz (1991) points out to us that "Common to most efforts of reformers is the belief that the problems and solutions to schooling lie in the scientific management of its environment. Educators see scientific management, and its offshoot, human engineering . . . as a plausible way to deal with social problems, such as those found in schools. Scientific management, it is believed, provides a rational and efficient scheme for manipulating the school environment to achieve desired outcomes." (p.5) The history of education in the United States supports that very notion. From the promotion of scientific management techniques as a solution to educational problems at the turn of the century, to the infusion of programmed instruction and instructional television of the sixties, the back to the basics of the seventies, to the language and models of business in the eighties and nineties (especially through the current interest in total quality management, expert systems, and outcome based education), supporters of bureaucratic and technocratic systems of thought have argued for more control over the schooling experience. Educational engineers if allowed will change what and how we think about teacher education, the work of teachers and the teaching-learning process (Heinich, 1985; Apple, 1982, 1993).

Rational for this type of intervention into the teaching and learning process has been built upon the constructed perception of ineffective, ill prepared teachers and failing schools that are unable to meet the needs of children and our changing society as they experience changing economic and social structures. Schools for the twenty-first century, we are told, will have to meet the challenge of the information society. Schools must be held accountable for producing citizens who are productive and will contribute to our society.

If schools can be held accountable, they can be controlled. For example, in *America 2000* (Bush, 1991) we are informed that "As a nation, we now invest more in education than in defense. But the results have not improved, and we're not coming close to our potential or what is needed." (p. 9) In the area of accountability the report suggests that "tests will be designed to foster good teaching and learning as well as to monitor student progress." (p. 13) School report cards will "provide clear (and comparable) public information on how schools, school districts, and states are doing, as well as the entire nation." (p. 14) Controlling the outcome, pre-determined ways of knowing, will control the how and the what is taught.

America 2000 calls for setting national goals, outcomes, and report cards. Teachers are to be given the control over the process by which the students arrive at the predetermined destination. The relationship between process and ends is clearly demonstrated in this document. "The American Achievement Test will examine the results of education. The test have nothing to say about how those results are produced, what teachers do in class from one day to the next, what instructional materials are chosen or what lesson plans are followed. The tests should result in less regulation of the means of education, because they focus exclusively on the ends." (p. 32) It is precisely this focus on the ends and not the means that points to a concern. If schools are to publish their test results as part of a regional, state, or federal report card, and public funding and support is seen as emerging from the results posted, teachers will teach to the test. Given the test, the means will follow. This may be especially true in communities that historically have not received high test scores.

Teachers, knowing that others see the test scores as reflective of their abilities to teach will spend most of their time and resources in meeting the needs of the test. If teachers are to turn around the public image of their profession and wish to compete for proposed merit pay increases their students and their school will need to do well.

Those who can do, do. Those that can not, teach. The public, mass-mediated image of the American teacher since World War Two has not been favorable. An analysis of film and television programs about the schooling experience usually positions the common teacher as non-effective, hopeless, or not very qualified. Consider for a moment films like "Black Board Jungle", "Teachers", "Stand and Deliver", and "Dead Poets Society", and you will find within them a gray portrait of the American teacher and the schools they work in. National reports, the mass media, and standardized tests all support the notion that a great part of the problem facing effective schooling is the teacher. As a result the profession has moved towards more layers of credentials and testing.

The language used to describe what a teacher is also defines how we "think" about what she or he does. Changing the professional role of teachers through "teacher-safe-materials", distant education, outcome based education, or as managers or facilitators of the curriculum points to a historically rooted distrust of, and an attempt to deskill teachers as autonomous, creative, reflective, and responsible professionals. Within changing definitions of what it means to practice the teaching profession, technology — hardware in the form of computer related devices, software that not only delivers but also evaluates the learner and are aligned with the test, and more sophisticated design systems — as a systems design offers the potential of more centralized control of the teaching-learning process. Peeling away the idealized vision and possibilities of a "Fox Fire" use of computers, one finds a system which regulates, controls and centralizes control in education.

School reform, and historically schools have always been reforming, have been founded upon principals of rationalism and technobureaucratic control (Muffoletto, 1988). The current interest in educational restructuring is no different.

As echoed in the document entitled *World-Class Schools: The Iowa Initiative* (1991) the purpose of education is to have a world-class system that "will equip students to live, work and compete as successful citizens in a global society." (p. 5) The document further suggests that its new vision for world-class education must be based upon knowledge that can be defined and measured. The role of staff members and educators (the document creates the difference) will be to create environments that help students meet outcome standards. It is interesting to note that the Iowa Business roundtable calls for the replacement of the current "authoritarian system of managing education" (p. 7) with a site-based and shared decision making model. Teachers and administrators in a newly defined participatory model will be expected to address the processes by which the previously identified body of knowledge will be delivered. The knowledge that teachers will deliver, and that students will learn, will be pre-determined by the test. The process, not the content and its form, will be left up to the teacher. The same teacher who is expected, in addition to what she or he does already on a day to day bases in the classroom, to work with portfolios, understand and contribute to the management of their school, develop stronger networks with parents and business, use the Internet, and to be an excited user of hardware and software.

The Iowa document also calls for the punishment of schools and teachers that do not meet predefined expectations. A guiding principle to the Iowa school improvement document states that "Successful schools, judged on the improvement of student achievement, should be rewarded, unsuccessful schools should be helped to improve and consistently inferior schools should be penalized." (p. 7) (The form of reward or punishment was not identified.) The report also recommends that rewards and punishments should "justify the substantial additional investment of Iowa funds in education." (p. 13) Besides financial support, punishments and rewards may cause a further "loss of faith" in public education. Parents, informed by experts, that test scores are an indicator of school quality may, if they are able to, place their children in what are perceived as more successful private schools. Public schools that need the most in financial assistance, parent and community support, could possibly lose the most. The children and parents who need a quality education program the most will possibly receive the least. In a funding system that is primarily based upon property taxes and the passage of local funding initiatives, the system keeps giving to those who already have (Apple, 1979; Kozol, 1991).

The Iowa report echoes the *America 2000* report in that it values and calls for control of outcomes. If students do not meet the expectations of the "ideological we", concerns over process and its delivery are called into question, not the expectations.

Finally the Iowa initiative addresses technology. Technology use here does not refer to the open-ended, humanities centered possibilities, but to the enhancement and efficiency of the "delivery of advanced level courses, staff development, assessment, data collection and analysis, administration and instructional materials." (p. 16) Since the curriculum is set by the test, the efficient delivery by various hardware and software not only changes the definition and role of the teacher, but defines the epistemological horizon as well. Expert systems, as delivery systems of instruction, may work well and appear to be effective, until we have no experts left (Garson, 1988).

Conclusion

Understanding technology and school reform as a discourse of change is a complex matter. As I have suggested, the first challenge is to unpack the language and context of restructuring used by policy makers and various change agents that create the context for legitimizing change. The second challenge is to situate the discourse on technology and school reform within a broader social, political history. When thinking about school change we need to consider from what frame of mind change is called for and what are its implications for the lives of real people? The role of technology in educational change will not be approached from a hardware or device level, but one from a technocratic, technological, and scientific perspective (Popkewitz, 1982). Understanding the role of science in a technology of human control is critical for our understanding of schooling in a post-industrial, information based society.

Unpacking the historical and current interest and movements in educational reform is no simple task (Muffoletto and Knupfer, 1993; Popkewitz & Shutkin, 1993). Understanding reality as a social construction is no simple matter (Goodman, 1978). But, if we are to consider what it means to re-think the schooling experience, we also need to consider why we are asking the question in the first place, and "who" is the ideological "we" that "we" so often hear about (Cuban, 1990; Muffoletto, 1991).

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Virtual Reality: Information Design in Cyberspace

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Virtual reality is an exciting new technology that uses the computer to create artificial environments. It is expected that in the future, these artificial environments will become so real that you will almost believe that you are in the environment. The purpose of this paper is to provide professionals interested in the systematic design of instruction with a brief overview of virtual reality and how it will impact on the process of instructional design. Some other terms used to describe virtual reality include artificial reality, synthetic environments, and information design (Haywood, 1993).

In his science fiction classic *Neuromancer* (1984), William Gibson describes a world that existed only as information. Gibson's world was a *consensual hallucination* that people could *jack into* at will. This world was so real that a person entering it would (assisted by psycho-active drugs, psycho-surgery, and other things we do not recommend) perceive it as real. The term Gibson coined to describe the world, *cyberspace*, is in common usage today. For example, there are cyberspace worlds currently on the Internet. Although text based, these worlds provide an electronic representation of cities, workplaces and fantasy worlds. In the not too distant future, it seems certain that many of these text based worlds will be transformed into true virtual reality environments with all the interactive tools needed to navigate through them. For anyone interested in the possibility of technology enhanced learning, they should investigate these primitive worlds that exist in today's cyberspace. They are the precursors of the virtual reality worlds of tomorrow.

Information Design

We use the term information design to describe the process of creating the virtual learning worlds of the future. Because there are no physical limitations in cyberspace, the information designer will be free to create worlds that the user can explore at will. In a virtual reality world, discovery is not just *learning-by-doing* as characterized by Dewey but *doing-is-learning* (Rheingold, 1991). Thus, it will be the task of the information designer to create environments that require the learned to solve real problems as he navigates his way through the artificially created microworld. This will allow learning to become more meaningful by involving the whole body in the process (Krueger, 1991).

Imagine exploring a foreign culture created by an information designer. The learner becomes so totally immersed in the language and behavior of the culture that he almost believes that he is there. Learners can explore the museums and government centers, and learn about the culture almost first hand. Using virtual reality, information designer's can create cultures from past history or, if needed, cultures that never existed. Cyberspace learners will have all of the advantages of foreign travel from the comfort, safety, and convenience of their home or classroom.

With the help of an information designer, science students can perform experiments in safe virtual laboratories equipped with limitless virtual equipment. This will allow students to perform experiments that are too expensive and/ or too dangerous to do now. One can easily imagine the advantages of studying physics with Einstein or astronomy with Carl Sagan. In a cyberspace laboratory, the experiments need not be bound to any specific laws of physics, chemistry or biology. Virtual reality gives to information designers the ability to create worlds that would allow learners to explore Mars, travel to the stars, or dive to the depths of the ocean. It is easy to see cyberspace learning environments in virtually every subject area.

The instructional design process has already been significantly influenced by the emergence of computer technology. For example, in traditional instructional design paradigms, great emphasis is placed on sequencing instruction. This sequence is determined by an expert instructional designer and is generally based upon contemporary learning theory. The development of hypermedia, multimedia, and computer simulations forces us to think of new paradigms that do not rely on sequential learning. Rather than specifying a step-by-step learning sequence in which the learner must discover correct answers, instructional designers can place the learner into a world created inside the computer. Learners placed in these microworlds can engage in genuine problem solving activities. In these types of learning environment, there may not be a single correct answer or method of solving problems. Simulation like *Sim City* have shown that you can learn much more about cities by engaging in problem solving activities than by memorizing facts about how cities work. Making decisions, rather than choosing the right answer, makes you a successful learner. Educators generally agree that engaging learners in problem solving activities can lead to effective learning (Prawat, 1993). Virtual reality promises to take computer simulations, hypermedia, and multimedia a giant step further.

Overview of Virtual Reality

Assuming that the trend toward lower-cost, higher-power computers continues, computers will soon possess sufficient power to create such rich artificial environments that it may be difficult, even almost impossible, to distinguish it from "real reality." Today's virtual reality systems are primitive, and no one in today's cyberspace worlds would be likely to be fooled into thinking it was real. Figure 1 compares the amount of overlap between a virtual world and the real world. The figure shows that today's virtual reality and the real world only slightly overlap. In the ultimate virtual reality system, the overlap will be greatly increased. It is easy to believe that in the near future, the situation will be closer to the ultimate virtual reality systems.

Although today's systems are not very advanced, they are based on the same four essential principles that, as they evolve, will become the basis for the systems of the future. These principles are called viewpoint, navigation, manipulation, and immersion. Below is a brief explanation of these principles.

Viewpoint refers to the point of view or perspective of the learner. In traditional simulations, the learner is basically watching the situation from the outside, as if on television. In cyberspace, the world is perceived from the learner's point of view. Some of today's systems attempt to accomplish this by simply displaying the point of view on the monitor. No matter how good your monitor is, you are still outside the world. More sophisticated systems use input devices called head mounted displays (HMD's) that allow the computer to direct separate images to each of the learner's eyes, simulating three-dimensional vision (Lavroff,

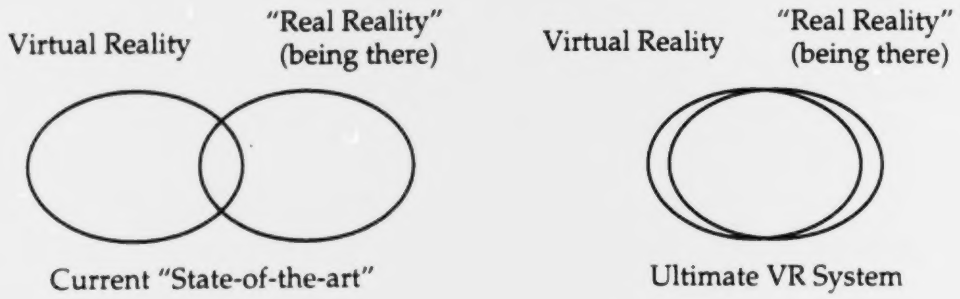
Virtual Reality
"Real Reality" (being there)
Current "State-of-the-art"
Virtual Reality
"Real Reality" (being there)
Ultimate VR System

Figure 1. Current VR Systems vesus "Ultimate" VR.

1992).

There are several models of HMD's currently available. The EyePhone, manufactured by VPL Research, is perhaps the best known of these devices. The view provides a 100 degree perspective, which approaches a normal point of view. While the EyePhone is designed specifically for virtual reality applications, it is fairly clumsy, weighing over two pounds. The Cyberface II (LEEP Technologies) is based on technology that utilizes a special camera to take three-dimensional pictures. It's color liquid crystal display functions in a similar manner as the EyePhone, but provides a 50% greater field of vision. There are also some cheaper, less sophisticated systems available including the Flight Helmet (Virtual Research) and the Binocular Omni Oriented Monitor (BOOM) from Fake Space Laboratories (Hamit, 1993). While the resolution and speed of these systems couldn't fool you into thinking you are in the simulation, future systems, driven by increased computer power and speed, will enhance the learner's perception of themselves as being inside the world. Head mounted displays can also act as input devices, telling the computer when the learner is turning her head. As in the real world, when the learner in cyberspace moves her head to a new position, the point of view changes.

Navigating a cyberspace world presents some unique problems. The most intuitive way of moving in a virtual world, walking, is simply not practical. Having people who are blinded to the real world walking around in a small space seems dangerous, if not foolish. Simple systems, like the ones that display the viewpoint on the monitor, often use a joystick to allow the user to communicate the direction she wishes to move. However, joysticks are only capable of moving in only four direction: forwards, backwards, left, or right. This makes it a poor simulation of moving through a world. Higher end systems use devices that attach to the user's body and directly feed responses into the computer. Input devices like data gloves provide the computer system with the ability to react to learner's movements allowing her to navigate by pointing in the direction she wants to move (Hamit, 1993).

Another central principle of virtual reality is manipulation. The most direct method of manipulating an object in a cyberspace world would be to reach out and grab it with a virtual hand. It seems obvious that a properly constructed data glove would be a natural way to control this virtual hand. The movements of the users hand can be directly mapped onto the virtual hand. As the user moves her hand, the virtual hand responds instantly (Hamit, 1993). This is not quite as easy to accomplish as it might seem. The movements of the human hand are extremely complex and subtle, and processing these movements and translating them into the virtual world in real time takes more computing power than is currently available. Even if it were possible to do it, it would still fall far short of reality.

Data gloves, combined with HMD's, only provide the user with visual feedback on the effects of her movements in the virtual world. When humans manipulate objects in the real world, they depend on other forms of feedback including temperature, pressure, balance, and many others. The fact that it is possible to design devices that successfully simulate these forms of sensory feedback can be seen by visiting Disney World, Universal Studios, or your local video arcade. In the future, it may even be possible to design systems that directly stimulate the neuroreceptors in the human body. These systems may have the ability to directly stimulate the sense of touch, balance, smell, taste, and so forth. This form of direct feedback will lead even further into total immersion into the cyberspace world. While this vision may seem to confirm Gibson's worst scenario, it is important to consider the possibilities. We must engage in a dialog into the ethics of the technology before it is developed.

Immersion, the final aspect of cyberspace, is of special interest to educators. While everyone has seen how immersed children (and even adults) can become in computer simulations and games, virtual reality systems are even more involving. Because the learner perceives the world from his own point of view and can navigate and manipulate the world, the learner's level of immersion is increased. The degree of immersion that is desirable is another ethical and psychological question that needs to be considered.

Implications of Cyberspace for Information Designers

Because the process of developing a virtual world is similar to the steps in the instructional design process, we believe that instructional designers will make excellent information designers. The nine steps involved in creating virtual worlds include feasibility, planning, management, design, development, pilot, testing and quality control, implementation, and evaluation (Haywood, 1993). Most of these steps have direct analogues in the instructional design process. While the terms may differ, the processes in the instructional and information design paradigms are similar.

The first step, determining the feasibility of a project, is similar to a needs assessment. In this phase the need for the project is assessed, as well as costs and other possible constraints. This cost/benefit analysis is common to both paradigms. The project planning and project management phases in designing virtual worlds are somewhat unique. In these phases certain technology related issues, including the selection of hardware and software, must be resolved. If the virtual world is expected to be large, the question of staffing must also be addressed.

The design of the virtual learning world must, like other types of instruction, be based on performance objectives. These objectives are used to develop the specifications for creating the virtual world. It is during the creation of the virtual world that the information designer must possess skills not usually needed by an instructional designer. Information designers must possess a deep understanding of technology and learning theory and how they relate to each other. During this phase, an instructional designer spends a good deal of time determining the instructional sequence. We believe that this linear approach to learning is outmoded and does not represent the best way to learn. The task of the information designer is far more complex. The designer must create a world in which the learner determines what he is going to do and when he is going to do it. Somehow, after this virtual experience, the learner is expected to have mastered performance objectives. New paradigms of nonlinear instruction and assessment are needed to determine how this might be accomplished.

Once a prototype of the world is developed, it must be thoroughly piloted and tested. This step, called formative evaluation in the instructional design process, is needed to determine if the instruction is effective. The results of this step are used to improve the instruction. It is only at this point that we are ready to implement and distribute the product. As developers of the project, we will still want to conduct summative evaluation.

It seems obvious that the virtual world development process and the instructional design process are almost identical. It is time for those instructional designer's interested in the potential of virtual reality and cyberspace to begin experiment with it.

Conclusion

The level of involvement provided in cyberspace promises to radically reform not only the way we teach, but also what we teach. Although this technology will provide educators with unbounded opportunities, it remains to be seen whether educators will seize them. The educational establishment is conservative and tends to change slowly (a fact we are painfully reminded of whenever we visit a school's computer laboratory equipped with 64k Apple II's). Some school districts have done such a poor job of using the current, rather modestly priced technology, that we are sometime pessimistic.

On May 9, 1991 at a Senate subcommittee meeting, the then Senator Albert Gore asked a representative of VPL, a virtual reality company, about the educational implications of virtual reality. The representative replied that the company had indeed looked into the viability of products for the educational market. He reported that "..we simply could not identify a market for this" (Hamit, 1993).

It is essential that teacher educators interested in the potential of technology for developing learning systems familiarize themselves with the concepts concerning cyberspace and virtual reality. If indeed education is to move into the 21st Century, we as teacher educators must become information designers.

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Hypertext as A Theoretical & Practical Tool: The TIP Project

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The Theory Into Practice (TIP) project involves the development of a hypertext database for theories of learning and instruction. The database contains descriptions of 48 theories which are linked to 18 major concepts and 18 task/content domains (see Tables 1 and 2). Each theory description includes the following sections: overview, scope/application, example, principles, and references. Relationships between theories are identified by highlighted text within articles. These relationships can be connections between specific theories or to concepts that underly a number of theories. The theories are indexed in a number of ways including content domain, type of learning and task characteristics.

The TIP database was primarily developed to make theories of learning and instruction more accessible to educators. Despite the wealth of theory available, practitioners seldom make use of it in their teaching activities and the design of curriculum. When asked why, most teachers and trainers explain that they find it difficult to identify which theories apply to the specific task or subject matter they are teaching. Since there are hundreds of theories, many of which are very extensive, it is not surprising that practitioners find it hard to isolate principles or findings that might pertain to their current teaching concerns. The point of the TIP project was to investigate whether a hypertext database would make it easier for educators to find and use learning/instructional theory.

A major challenge in the project was to determine which theories to include (and exclude) from the database. Theories were selected for inclusion based upon their relevance to human learning and instruction (particularly adult learning). All theories come from published literature (English language only). Theories that focus on animal learning, neuropsychology, learning disabilities or teaching strategies are not included. The database also does not include theories of learning that have limited scientific support or are primarily philosophical in nature (e.g., Dewey, Frerie, Illich, Polanyi).

In cases where there are a number of researchers associated with a theoretical framework, the version associated with the originator or most prominent researcher is presented. The descriptions of theories provided in the database, including the examples and principles, were developed from the analysis of secondary sources as well as the primary works of the theorists. Furthermore, the descriptions present theories at a particular stage of development, usually their most well-known or recent form. Since almost all of the theories included in the database are substantial, the brief summaries provided only outline the basic ideas and implications.

While no formal evaluations of the effectiveness of TIP have been completed yet, the program has been used extensively by graduate students and researchers in education. Based upon the feedback provided, the program does help people find information easily about learning and instructional theories relevant to their interests. However, in

Table 1
Theories of Learning & Instruction Included in the TIP Database

Anderson, J.R.	ACT*
Argyris, C.	double loop theory
Atkinson, R.	mathematical theory
Ausubel, D.P.	subsumption theory
Bandura, A.	social learning theory
Bruner, J.	constructivism
Card, Moran & Newell	GOMS
Carroll, J.M.	minimalism
Craik & Lockhart	levels of processing
Cronbach & Snow	aptitude-treatment interaction
Cross, P.	adult learning
DeBono, E.	lateral thinking
Estes, W.	stimulus sampling theory
Festinger, L.	cognitive dissonance theory
Gagne, R.M.	conditions of learning
Gardner, H.	multiple intelligences
Gibson, J.J.	information pickup theory
Guilford, J.P.	structure of intellect
Guthrie, E.	contiguity
Hull, C.L.	drive reduction theory
Knowles, M.	andragogy
Landa, L.	algo-heuristic theory
Lave, J.	situated learning
Mager, R.	criterion referenced instruction
Maltzman, I.	originality
Merrill, M.D.	component display theory
Miller, Galanter, & Pribram	information processing
Newell, A.	SOAR
Newell & Simon	General Problem Solver (GPS)
Norman, D.A.	modes of learning
Pask, G.	conversation theory
Pavio, A.	dual coding theory
Piaget, J.	genetic epistemology
Reigeluth, C.	elaboration theory
Rogers, C.	experiential theory
Salomon, G.	symbol systems
Scandura, J.	structural learning
Schank, R.	script theory
Schoenfeld, A.	mathematical problem-solving
Skinner, B.F.	operant conditioning
Spiro, R.	cognitive flexibility theory
Sternberg, R.J.	triarchic theory
Sticht, T.	functional context
Thorndike, E.L.	connectionism
Tolman, E.	sign/significate theory
VanLehn, K.	repair theory
Vygotsky, L.S.	social development
Wertheimer, M.	gestalt theory

Table 2
Concepts and Learning Domains in the TIP Database

Concepts	*Domains*
Anxiety	Aviation
Arousal	Computers
Attention	Concepts
Attitudes	Decision Making
Cognitive/Learning Styles	Engineering
Creativity	Language
Feedback/Reinforcement	Management
Imagery	Mathematics
Intelligence	Medicine
Learning Strategies	Military
Memory	Perception
Mental Models	Problem Solving
Metacognition	Procedures
Motivation	Reading
Productions	Reasoning
Schema	Sales
Sequencing of Instruction	Sensory-Motor
Transfer	Troubleshooting

almost all cases, the database does not contain detailed enough information to be really useful. While more detail could be provided from the literature, in many cases, the kind of application-specific connections have not been described. Most theories have only been applied to one or two domains of practice (if at all). Furthermore, the theorists themselves would need to be consulted since valid inferences could not be made on the basis of the existing literature.

While the primary purpose of the TIP database is to help educators apply learning and instructional theory to actual teaching and training settings, it allows a number of interesting metatheoretical questions to be examined. For example, an analysis of the link densities among theories, concepts, and domains reveals that the connections between theories and concepts or domains are strong but the connections among theories themselves are weak. This suggests that major theories of learning and instruction have much less commonality than might be supposed (except by virtue of shared concepts such as schema, feedback, transfer, etc.). Theories tend to be self-contained in terms of their conceptual basis, empirical support, or applications.

An analysis of the connections among the principles derived for each theory resulted in 13 categories of theory (see Table 3). The theories within a category share a common focus and assumptions. Of course, some theories could be placed in more than one category — which establishes links across the categories. Principles from different categories of theories tend to be complementary rather than contradictions; they provide explanations at multiple levels or dimensions.

The TIP project has demonstrated the use of hypertext for metatheoretical analysis of learning/instructional theories. By examining the nature of the links in the database, it is possible to determine the degree of connectedness among theories, concepts and domains. However, there are many methodological concerns having to do with definition of links and the characteristics of the database. Development of hypertext databases for other theoretical domains using different hypertext systems would help to refine the methodology and further demonstrate the value of this technology.

Of particular interest would be the exploration of multimedia databases instead of just textual information. The inclusion of diagrams, graphs, photographs, animations, audio recordings, and video sequences would add new dimensions to the presentation of a theory. For example, one can imagine audio or videotaped interviews in which theorists explain the details of their own theories or provide critiques of other theories. Diagrams and animations could convey theoretical ideas that are difficult to express in words. Unfortunately, very little information of this type exists at present for theories of learning and instruction.

Also of interest is the availability of graphical browsers that would help users to visualize the relationships among ideas. A graphical browser displays links in visual form which makes it easier to see the pattern of connections. Some hypertext systems allow links to be categorized so that subsets of links matching specified attributes can be displayed. In the case of a theoretical database, links could

Table 3
Categories of Theories in TIP Database According to Common Principles

Adult Learning	Cross, Knowles, Argyris, Rogers
Social Learning	Bandura, Vygotsky
Situational/Content	Spiro, Sticht, Lave
Constructivist	Bruner, Ausubel, Carroll
Procedural	Card, Moran & Newell, VanLehn
Structural	Piaget, Scandura, Landa, Riegeluth, Pask
Instructional Events	Gagne, Merrill, Mager, Atkinson
Relationship	Wertheimer, Gibson, DeBono
Problem-solving	Newell & Simon, Newell, Schoenfeld, Tolman
Coding	Miller, Craik & Lockhart, Paivio, Salomon
Individual Difference	Cronbach & Snow, Gardner, Guilford, Sternberg
Semantic	Anderson, Rumelhart & Norman, Schank, Festinger
Response	Guthrie, Thorndike, Hull, Skinner, Estes

be typed according to the specific components (e.g., application, example, supporting research, principles, etc.) so that very focused relationships could be identified. Alternatively, typed links would allow the nature or strength of the connection between two items to be specified.

Clearly hypertext opens up many interesting new possibilities for metatheoretical analysis depending upon the nature of the theoretical database and the capabilities of the hypertext system. We believe this use of hypertext/hypermedia will become an important tool for teaching and research in all disciplines. The TIP project represents a very small beginning in this area.

Notes:

1. This work was originally done under the sponsorship of the Army Research Institute through the National Research Council Associate program, and was done in collaboration with Robert J. Seidel and Ok-Choon Park.
2. The TIP database is implemented in Hyperties for MS-DOS computers and HyperCard for the Apple Macintosh. Both versions of the program are now available commercially from Wadsworth Publishing Co.

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Toward a Theory of Educational Technology

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I watched her from a distance. She sat there hunched, her hands wracked with palsy, slowly locating each key. Her head would raise, chin caulked excessively toward the ceiling, as she reviewed the results of each click. A line was beginning to appear at perfect right angles to a series of vertical lines she had managed to produce on the computer screen during the past half hour.

"What are you making," I asked.

Her slurred reply was difficult to understand, but over time I had acquired an ear.

"A calendar," she answered.

Betty was a victim of cerebral palsy. This simple matrix she was creating, using a computer programming language, had allowed Betty to demonstrate both motor and mathematical expression, for Betty an expression of understanding she was often forced to hold solely within. Like many others in her classroom, she was "experiencing" educational technology.

Einstein once said, "God does not play dice with the universe." (cited in Lederman, 1993). These few words reveal a theory, a theory that the universe is purposeful and ordered. To understand the universe one investigates and uncovers its purpose and its order. Yet as logical, reasonable, useful, respected, and comforting such a theory may be, it is but a point of view founded in certain presuppositions. Another frame of reference, one couched in a view that all is chance and coincidence, may compel the scientist to theorize differently, to describe the universe as random and chaotic, our very existence a fluke.

In the same way theories of classical and quantum physics are founded in fundamental questions of material origin, social science and human science theory rest in a similar quest for answers to questions of ontology, epistemology, and axiology. These are the age old queries that account for the various disciplines of study and the multiple streams of thought ("isms") within disciplines. It is in these chapters of philosophy, psychology, sociology, anthropology, political science, and other such schools of thought that we find many of the traditional and contemporary ideas the field of education borrows and incorporates into answering its own questions.

What is the nature of knowledge? Is it absolute? Relative? Is it received through divine revelation, intuition, or through the senses? Through reason? Is it constructed out of experience? One might be tempted to say all of the above, and move on. In education, partially because of our interdisciplinary dependence, we tend to be pluralists, and do just that. Herein lies the problem. Even pluralism is a philosophic position, albeit often a schizophrenic one. As educators, we are in the "knowledge business," yet often unaware of the intellectual historicity ever present in the questions we ask and the answers we are willing to accept. Our theories are a product of our philosophies and our practices a product of our theories. Therefore examination of theory and practice should begin at the beginning, in our presuppositions.

What does this have to do with Betty and her experience of educational technology? This paper argues that a more thorough understanding of educational technology, and of students' educational experiences with educational technology, begins with a position on technology. Even as unlikely a candidate as educational technology may appear to be for philosophic scrutiny, our understanding of the influence and impact technology has on students may be examined from very fundamentally different points of view. If we see educational technology as only tools used and directed through the intentions of a teacher, we may be satisfied with understanding educational technology through the measurement of technology's effects on students. On the other hand, if we view technology as having its own intentionality, our understanding of educational technology may include an examination of technology's existential impact.

A Definition of Technology

Technology has its origins as a term in the Greek words "techne" and "logos". In the broadest sense "techne" refers to making. Through its Roman translation it became associated with "ars", methods or rules for the application of science, and "instrumentum", pertaining to tools and artifacts (Burch, 1984).

According to Marx (1975), the meaning of technology has "suffered from a kind of elephantiasis in recent years" (p. 7). He illustrates the growth of the term by offering three definitions, as they have evolved. The first, which remains close to its etymology, refers to the knowledge, skills, and equipment people use for practical purposes. The second refers to the bureaucratic organizations that surround this knowledge, skill, and apparatus, for example the rise of automotive, medical, space, and computer technologies, often referred to as industries. A third, and much larger concept of technology, he labels as "metatechnology" (p.8) whereby technology dominates and permeates the life of an entire society. The knowledge, skills, and machinery of society are institutionalized and become part of the national ideology. It is this latter portion of the definition of technology, metatechnology, that entices philosophers to target technology as a subject for inquiry.

A Philosophy of Technology

Until recently, developing a distinct philosophy of technology was considered questionable as an academic pursuit. Only in the 20th century has it been a recognized activity in North America, with attempts to formalize the pursuit beginning as late as the mid-sixties (Durbin, 1978). As Rapp (1989) suggests, "The field is still in the making" (p. ix). He offers the following explanations: 1) Western history of ideas has been dominated by the notion of theory. Practical activity and craft have been relegated to a much lower level of thought, and therefore not worthy of intellectual analysis; 2) There has been a dominant notion that technology is merely applied science and subsumed within a philosophy of science; 3) Prior to the industrial revolution, technology was taken for granted. It is only recently that technology has attracted much attention; 4) Disciplines which have attracted organized philosophic inquiry are those which have developed theories from systematic coherent models. The study of technology is multi-disciplinary, thus a coalescence of distinct ideas is more difficult to achieve.

Technology, for the most part, has been accepted as applied science. It is the major means of providing objects for human survival and comfort (Leiss, 1990). But tools were constructed long before science. According to Whitehead (1967, p. 96), "The greatest invention of the nineteenth century was the invention of the method of invention." Science, as the ultimate technique, is itself presupposed by something more primary. In this sense technology precedes science. The very existence of science depends on a technological world-view. Science presently receives a "best method" status where "the excellence of science is assumed, it is not argued for" (Feyerabend, 1982, p. 73). To consider technology as a priori is not to consider it as a collection of "overt techniques or artifacts," (Ferre, 1988, p. 66) but to consider it as technological thinking, a position supported in the works of Barrett (1979), Ellul (1964), Heidegger (1977), and Mumford (1967). However, due to interpretations that these authors are "anti-technological," (Ferre, 1988, p. 64) this perspective has to a large extent fallen on many deaf ears. They predict too much doom and gloom.

Nevertheless, the undeniable sense that we live in what Ferre (1988) refers to as a technological context or "technosphere", seems a viable reason to continue academic discussion and debate. We are so conditioned to a technological world that only startling announcements of technological advance or sudden loss of the use of a particular technology appear to cause concern or give rise to reflection. Yet, this ubiquitous technological backdrop to virtually all our activities, has in some way and will in some other way "shape for better or worse our self-conceptions, our social arrangements, our basic expectations, as well as our sense [of] what is normal and normative (p. 2)" Therefore, some critical wondering about technology is warranted.

This paper does not attempt to offer answers or solutions to epistemological, axiological, and metaphysical questions or problems, but instead offers a position on technology that may assist in posing new questions. For it is questions that direct us toward new ideas, new theories. Also, in interests of brevity, it deals primarily with the concepts of Ihde's (1990, 1979) "phenomenology of technics," not that Ihde's ideas can be dealt with in brief, but the complexity of his ideas allows us to discuss only a truncated version of them in this forum. As a phenomenology, Ihde's ideas are concerned with experience, how through human-technology relations instruments mediate experience and thereby transform experience.

Instrument Intentionality

Technology first mediates our experience by way of coming between self and the world. In "various ways I-as-body" (Ihde,1990, p. 72) interacts with the environment by means of technologies. Technology as mediating our "naked" relationship with the world, comprises the major thrust of Ihde's thesis that technology can be examined as more than "tools" and the "use of tools." As instruments mediate our experiences they also transform our experiences and can be understood as having "intentionality" (Ihde, 1990; 1976). In this sense technology is more than "doing." Technology becomes a way of "being." More simply, technology is not neutral. Its very use changes the user.

Embodied Relations

"Naked," our perception of the world is direct. Introduce technology, and those perceptions are mediated. A pair of eye glasses mediates our vision, a jacket our experience of the elements, and an automobile our sense of locomotion and distance. The more "transparent" the technology is experienced -in other words, the more one becomes conditioned to the technology - the more the technology becomes an extension of self. For instance, the wearer of eye glasses becomes accustomed to viewing the world through glasses. As such, the technology is more or less embodied and becomes more or less a part of "perceptual-bodily self experience" (1990, p. 73).

Hermeneutic Relations

Technology itself can become the object of perception. In this instance, the technology provides representation of something that cannot or is not part of perceptual-bodily self experience. For example, the spectroscope gives us a band of color that must be interpreted. The band of color represents an object, but the band itself bears no likeness to objects it represents. More recently, computer-generated fractal geometry (Gleick, 1988), often used for motion picture special effects, is being used by physicists, chemists, seismologists, metallurgists, probability theorists, and physiologists. From a text of swirling ever-changing patterns, scientists are learning about the paradox of random, chaotic, order. As instruments are understood as providing "representation" or "text," they become a "textual artifact " (Ihde, 1990, p. 82). The text is read and interpreted, thus the formation of a hermeneutic relation. However, hermeneutic relations need not be so dramatic. Even the simple introduction of tint to a pair of glasses changes the landscape and reveals the world differently, providing a new "text" for interpretation.

Alterity Relations

Cohen (1989) argues that objects cannot be "other." Objects do not question or claim. We are not obligated to objects as we are to others. We are the object of other's intentionality. Others give meaning to our being. In alterity relations the technology becomes a "quasi-other" through its "instrumental intentionality" (Ihde, 1990, 1976). Here the technology is encountered, engaged. It becomes something to master, defeat, learn from, or take advice from. The technology appears as if other, questioning the user, making the user more self-aware. The technology emerges as a focal entity. Computer technology is one of the more obvious candidates illustrating this human-technology alterity relation. During retrospective analysis the computer user is quite aware that the machine does not have the otherness of a human being; however, during interactions with the machine it often feels the same (Howard, in press). In some sense users feel they have been in conversation, in communication with the machine.

Technology in Education

What do we know of the mediating influence of the desks, bells, and blackboards? What worldview is being developed through multimedia and the Internet? How is teaching changed? Examining technology as a "way of doing," gives us insight into what technology does, but does little to improve our understanding of what technology means, giving us insight into the existential impact educational technology has on learners and teachers.

Examining technology as a "way of being," influences the questions one might ask regarding technology within the context of education. We can look beyond the effect projectors, computers, and video recorders have on student performance and begin to examine how technology mediates students' lives, what meanings students attach to the educational experience as a result of technological mediation, and what implications those meanings have for pedagogy.

Let's return to Betty and the other's in the classroom. We know Betty is doing more than she has done before. Through her activities with the computer programming language, she has overcome a severe physical disability and can express mathematically and graphically what she was previously unable to express. We can measure that. But there is a richness in Betty's experience we cannot measure. Examining the relations she is having with this technology enables us to more fully understand and articulate the educational impact of this particular technological mediation.

Betty's Embodied Relation with the Computer

The experience of intersecting two points, A and B, by drawing a line, requires Betty to move her hand across the surface of a medium. Her perceptions of drawing a line, although mediated through the pencil, are directly associated with the tactile sensations of moving her hand in a given direction. Directing the computer to do the same task changes the perception of that experience. Her bodily sense of making a line is radically changed, also changing her tacit understanding of making lines. With practice, the manipulation of the computer cursor will become "familiar" to Betty and she will experience line-making as a computer activity. The computer gradually extends her bodily capacities, as Ihde (1990, p. 75) suggests, "into new realms" of perception. The questions become: What new realms? What is experienced in those realms? What are the experiences like?

Betty's Hermeneutic Relation with the Computer

Betty finds entering commands on the computer keyboard, which are eventually translated into the illumination of a straight line of pixels on a computer screen, more satisfying than using pencil, paper, and ruler. However, the line on the screen, although it has similar properties to the pencil line on a piece of paper and can be recognized as a rendition of a line, has different qualities and potentials, and is thus displayed as different "text." Betty has discovered that the lines she is drawing can be manipulated. She can make them appear slowly or quickly. She can even make them wiggle. As the lines, in cartoon like fashion, appear to be drawing themselves, Betty is able to express line drawing outside previous constraints. The embodiment relation Betty has with the computer evolves into a hermeneutic relation. The questions become: What new meanings are attached to these new expressions? What more can Betty say through her renditions? What new reading is Betty giving to what the computer is rendering through her commands?

Betty's Alterity Relation with the Computer

Betty interacts with the computer. She delights in making the lines and manipulating the creations. She frowns in frustration when certain sequences do not work out to her satisfaction, sometimes poking at the keys as if to discipline the computer for its misbehavior. Watching Betty work with the computer is like watching her work with another member of the class. From a hermeneutic relation, the computer and Betty begin to develop an alterity relation. As she interacts with the computer, she develops a new sense of confidence, a new sense of self-awareness. The computer assists in revealing Betty's ideas, her thinking. It helps her express herself. In the same way others, through their opinions, actions, and intentions claim their non-neutrality in Betty's life, the computer increasingly influences Betty's sense of what she can and cannot do. Her perceptions of her abilities change. The questions become: In what way is Betty's self-awareness changed? What limits does the computer impose on Betty's world? How will Betty explore her world differently?

Conclusion

Technology is ambiguous (Ferre, 1988). We make reference to artifacts and practices as technology and then suggest that technology is what makes these "things" possible. Technology may be both. Our relationship with the world is partly established through technology. It is established through a way of thinking and through a way of practice. We both discover and construct a technological reality. We view "things" as useful and proceed to use them. More explicitly, discovering a hammer reveals the world as hammerable (Heidegger, 1977). Discovering a gun reveals the world as shootable. Discovering a computer reveals the world as computable.

Many would agree that the school's job is to effect some favorable change in the student's learning behavior. In this sense, education is centered in actions, performance and outcomes. As such, education tends to be thought of as a treatment and educational technology as the tools and procedures useful in effecting that treatment. To understand educational technology more completely we must attempt to understand its lived meaning. Ihde's ideas of instrument intentionality and technology relations, may help us do that. By recognizing the "intentionality" of educational technology and examining the "relation" it has with students and teachers, we can add depth to our understanding of educational technology and move toward a more thorough analysis of its existential impact, thereby extending our ability to be more critical of its use in our schools. Educational technology must be understood and used with tact.

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Reflective Thinking About Technology for Students and Teachers

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Much has been written and discussed on how to integrate technology into teacher education programs, and thereby into the K-12 classroom, but little has been written on whether or not such infusion is warranted and what effect it might have upon the institution of schools and the concept of learning or knowledge as we know them today. This paper will provide some food for thought on this question. I am not, however, against technology in education. Rather, I am for seriously considering how technology actually changes the curriculum for preservice teachers, inservice teachers, and their students and what we, as teacher educator's, must do to foster those changes.

Defining Technology

Before we begin, let's define some terms so we know we are on common ground. What exactly is technology? We all talk about it, but do we really understand the significance of the word? According to The *World Book Dictionary*, 1990 (p. 2154), technology is the "body of tools, machines, materials, techniques, and processes used to produce goods and services and satisfy human needs." In other words, technology is everything humans make and use from the simple wheel to the most sophisticated computer, including the processes and techniques involved in using the tools, machines, and materials.

Technology surrounds us and yet many fear technology and its role in our society. Without technology, there would be little difference between us and other animal species. The ability to use technology is one of our defining characteristics. The fact that our technologies are continually evolving, doing more and more tasks for us, doing our tasks faster, and often better, is at the heart of technophobia. We all accept the wheel and have no fear of it, enjoying the many benefits it provides to our way of life. But the wheel has been with us for many centuries and then some. What becomes frightening is the newer technologies, especially as we see them encroaching upon what we thought was our exclusive turf. We readily accept technologies to help us with physical tasks, but when technologies become available to help us with mental tasks we become more concerned.

Historical View

When new technologies are first introduced, they are often used to imitate older technologies. For example, think back to the introduction of the automobile. The first automobiles looked very much like horseless carriages. In fact, that's what they were called. The idea of the automobile was to speed up traveling time over horse-drawn carriages. However, over a period of years, spin offs from the automobiles came into being and the style of the automobiles evolved into machines that today barely resemble a horseless carriage other than having four wheels. The social changes brought about by the automobile, from drive-in movies to drive-in banks, have been more profound than the actual idea of speeding up travel time. Indeed, the impact of the automobile on society has allowed other changes to take place that dramatically alter the way society operated in the pre-automobile days to the way society operates today.

The telephone can be viewed in the same manner. Alexander Graham Bell would be quite surprised to see the telephone as such a pervasive piece of technology, literally making voice, and now even data and video communication, accessible to nearly everyone in the world at any time of day or night.

This acceptance of a technology, literally changing the institutions and social structures of a society, can easily be seen historically. It is somewhat more difficult to foresee the changes in the present and immediate future, but that is exactly what the computer and related technologies are doing to our world today. We have yet to see what the full impact of having a computer in each person's hands at all times will do to social institutions, especially schools. For the most part, computers in schools to this date have been used as faster, more accurate textbooks and workbooks for students. In some schools, the use of word processing has replaced instruction in typing, and it is evident from the physical layout of the first versions of microcomputers that they were designed to imitate typewriters in their method of data input. After over a dozen years we are finally beginning to break the mold by separating keyboards from the CPUs and even design different shaped keyboards as well as other types of input devices such as scanners for optical input and microphones for voice input.

Education as a Technology

How does this relate to education as a technology and using educational technologies in the quest for knowledge/learning? First, education as the technology we have known for the past few decades is relatively new in relation to the history of humankind. It is only in this century that massive public education for all has been a goal. We often act as if that has been the case since Plato and Aristotle began teaching.

What technologies did Plato and Aristotle use in their teaching? Essentially, they were content with audio technologies, that is, speaking and listening. In fact, the history of humankind survived through audio technologies for many centuries. When written communication came into being it was limited to a very select few and only with Guttenburg's invention of the printing press did massive written communications finally become available to the common people. At each step, there was concern about what the new technologies would do for the learner, how the learner would become dependent upon the technology, and how people would no longer be able to do the "real" work independent of the technology's assistance.

Knowledge and Learning

As we work through this, we need to identify what we mean by knowledge and learning. If we define a student's knowledge of a subject, let's say spelling, as what is stored in his/her brain, without the aid of technologies of any sort, then how should we test that student's knowledge? The answer, of course, is that the only way to test knowledge of spelling in one's brain without the aid of technologies would be through oral spelling tests. The teacher reads a word and the student recites the spelling orally back to the teacher. But wait a minute. What is the true purpose of spelling? Is it not to be able to write words correctly so the reader of your work can understand your message? Essentially, spelling's only purpose is for fostering correct written communications. But, what do we need in order to communicate in written form? Pencil and paper are necessities. The use of pencil and paper allows the learner to look at his/her spelling of the word and judge it from its visual pattern, often saying to him/herself, "No, it doesn't look right."

If the use of visual cues fails, teachers generally suggest students "Look it up in the dictionary." What is a dictionary if not a technological tool used to supplement memory of the spelling, pronunciation, definition, part of speech, etymology, etc. of a word. We readily recommend to students the use this tool when writing papers but what do we do when they take a "spelling test?" Are dictionaries allowed for "spelling tests?" Of course not, we want to know what is in the students brain, not what is in the dictionary. We allow them paper and pencil, primarily because they make it easier for us, the teacher, not because they aid the student in his/her recall. If we had the time and energy, ideally most teachers would prefer an oral spelling test to really determine if the child knows the spelling. At the same time, however, spelling is never done in the "real world" orally, it is always with pencil and paper and most often with the aid of a dictionary if so desired. The true judge of one's spelling abilities is in the papers one writes. If a student is capable of producing written communications that include all or mostly all correctly spelled words, regardless of how those words were correctly spelled, should be the true measure of that student's spelling ability. The use of tools to support our mental activities, as partners in cognition (Salomon, Perkins, and Globerson, 1991) is essentially what is happening in this case.

Enter the Computer and Related Technologies

With the advent of the computer and related information technologies, our concern over what the student is learning becomes even more pronounced. Now we have tools that can compute any mathematical formula given it, that allow us to write without a lot of preplanning, that allow us to check our spelling and grammar, that allow us to instantly produce graphs and charts depicting data, that allow us access to more information than we can digest in a lifetime.

The decisions we make regarding the use of these technologies by students in our classrooms will ultimately vastly change what is stored in the students' brains. We cannot continue in the same paradigm as we have for the past few decades. We must embrace these technologies and teach our students how to use them to manipulate information to their desires. We can no longer believe or be content to believe that we can teach students what they need to know. Instead we must teach them how to use these cognitive technological tools. What the students will store in their brains will not be the same as what we stored, namely facts and formulas. Instead, the cognitive tools will take over many of these menial tasks for the student, allowing the student to develop higher order skills such as problem solving, evaluation, analysis, and synthesis. These tools can make the repetitive work of schools less tedious and more exciting for students so they engage in more varied learning experiences. No longer will students have to memorize the states and capitals. Instead, they will learn how to use a database program to locate a specific capital of a state that is needed for the project currently being studied. In addition, integration of separate disciplines is fostered by these cognitive tools that can manipulate data in and between multiple formats, for example between word processing, data bases, spreadsheets, and charting programs.

Myths About Cognitive Technologies

This discussion will most likely cause some real concern on the part of many teachers, administrators, and parents. The belief that these cognitive technologies do the work for the student is widespread. Nothing can be farther from the truth. When was the last time your word processing program wrote a paper for you? (I wish mine would sometimes!) Think about the spell checker program. What exactly does it do for the user? Does it tell you how to spell words or does it merely identify words it doesn't like and then throw the ball back into your court? And what about calculators? When was the last time your calculator decided to add three numbers together asking nothing from you? I have yet to see a calculator that didn't need to be told what numbers to work on and what operations to perform on those numbers.

What does all this mean to the education of preservice teachers, inservice teachers, and their students? Preservice and inservice teachers must be technologically up-to-date. Discussions in methods courses and/or technology courses should focus on the ideas expressed above. Active, thoughtful interaction on these topics is paramount. Unfortunately, most preservice and inservice technology courses or workshops focus on the how-to's, not the why-to's. If our preservice and inservice teachers are given the opportunity to debate these issues openly in a friendly supportive atmosphere, then many more will be willing to learn the how-to's we so readily provide.

It is my belief that knowledge and learning are supported by cognitive technologies in the out-of-school, "real" world and that as teachers, we should be utilizing the same tools in school learning. But, in order to fully take advantage of what they offer, we must know what they do and don't do for the teacher, the learner, and knowledge.

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A Conceptual Model for Examining Disciplinary Differences in Teaching with Technology

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Since the compartmentalization of knowledge into disciplines and academic fields gained momentum in the late 19th century, there has been a continuing interest in, to adapt Adler's phrase (1967), the difference in disciplines and the difference it makes (King and Brownell, 1966; Kuhn, 1970; Phenix, 1964; Schwab, 1964; Snow, 1959). In recent years, research has begun to focus on these disciplinary differences and what they may mean for college teachers in their work (Andresen, Barrett, Powell, and Wieneke, 1985; Stark, Lowther, Bentley and Martens, 1990). A major finding in this work has been that the faculty member's discipline is a major factor in course planning along with their assumptions about students(Stark and Lowther, 1990).

Paralleling this work has been a line of research on using technology, particularly computer related technology, in teaching. Maddux (1993) suggests that research in educational computing has evolved from early simplistic and often erroneous assumptions to the current more sophisticated stage of "asking which and how learner and learning variables interact with teaching variables as they relate to specific dependent variables." (p. 18). An opportunity exists for these two paths of inquiry to intersect, with the potential for understanding more about different disciplines' approaches to teaching with technology. Since the preparation of teachers involves faculty outside of schools and colleges of education that represent much of the disciplinary spectrum, such a line of research would seem to be worthwhile.

The purpose of this paper is to present a conceptual model for studying disciplinary differences in order to elicit an understanding of the disciplinary factors that contribute to a faculty member's approach to teaching with technology. Components of the model include: the structure and ethos of the discipline (e.g. goals and aims, ontological and epistemological assumptions, modes of inquiry, values and beliefs); preparation for and experience as a teacher; faculty assumptions about students; faculty beliefs and perceptions about technology; and institutional context.

The Structure and Ethos of the Discipline

The basic question may be stated as this: is there anything inherent in a discipline that might influence whether or how technology may be employed in teaching? To better understand the contribution of a field of knowledge in this context, it should be useful to briefly review how we have come to think about the organization of knowledge. Although disciplines as we have come to know them are largely a creation of the Scottish Enlightenment, the concern over the organization of what we know dates to antiquity.

Plato's organization of knowledge is outlined in *The Republic*. Not concerned with the disciplines and subject matter in the classification of knowledge, he was less interested in the "visible" than the "intellectual," that is, in the unity of all things and the dialectic as the mode of inquiry to attaining that goal. He thought that knowledge resided in each individual and was to be recollected and not cognitive technological tools. What the students will store in their brains will not be the same as what we stored, namely facts and formulas. Instead, the cognitive tools will take over many of these menial tasks for the student, allowing the student to develop higher order skills such as problem solving, evaluation, analysis, and synthesis. These tools can make the repetitive work of schools less tedious and more exciting for students so they engage in more varied learning experiences. No longer will students have to memorize the states and capitals. Instead, they will learn how to use a database program to locate a specific capital of a state that is needed for the project currently being studied. In addition, integration of separate disciplines is fostered by these cognitive tools that can manipulate data in and between multiple formats, for example between word processing, data bases, spreadsheets, and charting programs.

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taught. Using the imagery of the allegory of the cave, he argued that reasoning from particulars, one uses the intellect to realize "Universals."

Aristotle organized the sciences into a hierarchy according to their end and intrinsic character: the theoretical, the practical, and the productive. The theoretical disciplines were fixed and stable, to be known for their own inherent value. These included physics, mathematics, and metaphysics. The second class was the practical disciplines. These were changable matters with good for humankind being their object. Ethics and politics were these disciplines with politics being further divided into economics and rhetoric. The third class is the productive disciplines: fine arts, applied arts, and engineering.

Aristotle's hierarchy valued knowing over doing and making.

Descartes argued for a single science based upon unity and without the diversity of disciplines. For him, this was a deductive system resting upon first causes and principles, "Thus philosophy as a whole is like a tree whose roots are metaphysics, whose trunk is physics, and whose branches, which issue from this trunk, are all the other sciences." (cited in King and Brownell, p. 43). In the Cartesian organization, knowledge is based upon mathematics and is grounded in the individual mind and self.

Immanuel Kant's conception began to move things closer to the views that have dominated for the last century. He argued for a clear division of the disciplines that derived either from empirical or historical data, or from rationally determined principles, and that all this related to an integrated whole. The organizing principle of that whole was judgment; however, each discipline varied according to mode of inquiry and a "regulative idea."

King and Brownell (1970) argue for a special place for Giambattista Vico in this brief history of the organization of knowledge. Vico argued that the organization of knowledge was a creation of the logic of the mind rather than some external reality; it comes from a 'logic of the imagination.' He says that knowledge comes from inquiry based in what humans have made rather than from reason and scientific observation and experiment alone.

Auguste Comte contributed the idea of the "positive sciences," his hierarchy being sociology, biology, chemistry, physics, astronomy, and mathematics, with development proceeding from mathematics upward to sociology. Knowledge is limited to these disciplines that are based upon sense experience, what can be positively known.

This "hegemony of philosophy" prior to the twentieth century, as King and Brownell have called it, gave way to the logical positivists in the 1920s and 30s who dominated the discourse until more recently. Now, positivism is giving way to post positivism. Constructivism and critical theory are offering alternative conceptions regarding what can be known and how we know it. And there are those who argue for the readmission of metaphysics to the discussion.

This history of ideas is helpful to our inquiry in that it illustrates a long and continuing struggle to identify a conception that is inclusive of the phenomena we believe bear on knowledge, and how some of the ideas we hold have come to us. It also suggests that these discussions will likely continue. What then do we make of this in terms of our task at hand? One impression from this history seems to be that conceptions of the organization of knowledge are all products of the mind. The rationale for their development and the viability of their argument all spring from the imagination. (Perhaps we should look more closely at the work of Vico). Each conception attracts adherents and, over time, traditions grow up around these ideological enclaves. So part of the picture must necessarily be an examination of a particular discipline in terms of its ontological (What is the nature of reality?), epistemological (What is the relationship between the inquirer and reality?), and methodological (How does one find out this reality?) assumptions, as well as the heritage and traditions that have grown up around it. But a broader conception is required to understand its contribution to the complete experience of teaching, and further, to incorporating technology into teaching.

Understanding the structure and ethos of a discipline is in itself not enough; we are left with an incomplete picture. A more complete conception is offered and reflected in this paper. The Structure and Ethos of a Discipline takes its place among several other factors that come into play in considering the use of technology in teaching: Faculty assumptions about students, Faculty beliefs/perceptions about technology, Environmental contexts, and Preparation and Experience as a Teacher.

Using this conception, we may, with further research, uncover ways in which disciplinary differences can influence the way technology is used in teaching. We turn now to an explanation of these other factors.

Faculty Assumptions About Students

A second key area in examining potential differences among disciplines with respect to using technology in teaching is faculty assumptions about students. In their study on disciplinary differences in course planning, Stark, Lowther, Bentley and Martens (1990) found this factor to be important in influencing how faculty plan their courses. They noted that faculty adapted their preparation based upon student variability, particularly with respect to student needs for intellectual growth and student preparedness.

In a separate work, Stark, Shaw,and Lowther (1989) argue that information on student goals is generally neglected in colleges and universities, but that there is evidence that student goals factor prominently in the approach of students to their work: "students have broad goals for attending college, narrower goals for achieving in particular courses, and even more specific goals as they approach each learning task."(p. vi). And since students continue to develop during their college experience, goals should not be viewed as static; they evolve and change with the student's continuing growth. Stark et al. (1990) recommend, and common sense would suggest, that faculty need to pay more specific and systematic attention to student goals.

The burgeoning literature on student development has,

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in recent years, produced increasing sophistication in the understanding of how students develop during college (Upcraft & Moore, 1990). It seems increasingly imperative that faculty, who care about their teaching and a productive role that technology might play in it, make greater use of the knowledge of student goals and development.

Preparation for and Experience as a Teacher

A third factor in the model involves the level of sophistication one possesses as a teacher. This derives from formal preparation as well as experience. Conceptions such as that offered by Shulman (1987) as he discusses teacher knowledge with respect to his "pedagogy of substance" help to elucidate the complexity of this area. Shulman argues that a successful teacher learns how to teach, and continues to learn, by studying not only in a specific content area but also in fields related to teaching (e.g., history, philosophy, psychology, sociology) and in the liberal arts. The general areas in which teachers need substantial knowledge in order to promote student learning are, according to Shulman (1987, p.8):

- content knowledge (the discipline);
- general pedagogical knowledge, with special references to those broad principles and strategies of classroom management and organization that appear to transcend subject matter;
- curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers;
- pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own professional form of professional understandings;
- knowledge of learners and their characteristics;
- knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and finance of [education], to the character of communities and cultures; and,
- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Acquiring breadth and depth of knowledge in these areas will, says Shulman, enhance the likelihood that faculty will develop the competencies which will allow them to communicate, with increasing sophistication, what they know to their students. The competencies, which are influenced by all the teacher has experienced as well as virtually everything he or she has studied, encompass their abilities to:

- comprehend both content and purposes (p. 15);
- transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the varieties in ability and in background presented by the students (p. 15);
- [organize and manage] the classroom, [present] clear explanations and vivid descriptions, [assign and check] work; and [interact] effectively with students through questions and probes, answers and reactions, and praise and criticism (p. 17);
- check for understanding and misunderstanding. . .while teaching interactively, as well as [by]more formal testing and evaluation that teachers do to provide feedback and five grades (pp.18-19);
- [reflect on] the teaching and learning that has occurred, and [reconstruct, reenact, and/or recapture] the events, the emotions, and the accomplishments (p. 19); [and]
- arrive at a new beginning. . .with new comprehension, both of the purposes and of the subjects to be taught, and also of the students and of the processes of pedagogy themselves.

The preparation one has received in these various areas, combined with the experience gained over time, must be taken into account when examining how faculty members from a particular discipline approach the use of technology in their field. Variations in training received, view of teaching as a priority, and individual personality differences all factor into this aspect of the model.

Environmental Context

A fourth factor bearing on the understanding of disciplinary differences in the use of technology in teaching relates to an individual's institutional context. In the Stark et al. (1990) study on course planning cited above, the context in which teaching occurred was noted as important, though not as important as the disciplinary teaching field. Percentages of faculty reporting contextual factors as strongly influencing their decisions varied widely with the average being one in five. Certainly, availability of the desired technology would be an important factor, as would technical assistance in training and service.

Stark et al.(1990) also suggest that "it may help to increase the visibility of services designed to improve planning or instruction" (p. 162). Campus wide Teaching Excellence Centers around the country often specifically address technology use strategy and support issues. The availability of such centralized services on a campus may be an important environmental factor in creating a climate in which technology can be integrated into teaching.

Faculty Beliefs and Perceptions About Technology

The fifth aspect of this model involves faculty beliefs and perceptions about technology. This is closely related to Preparation for and Experience as a Teacher, but warrants consideration as a separate factor due largely to the relative newness of computer related technology on the college teaching scene and the multifaceted complexity it can introduce to the work environment of college faculty that crosses teaching, research,and service boundaries.

Faculty attitudes regarding possible roles for technology in their teaching derive from the relative sophistication of their knowledge about the productive uses of technology in their personal private work and in their public teaching work. Most faculty have embraced the computer as a personal productivity tool for writing, E-mail, and processing research. Most, however, have yet to take the next step and use computer related technology as a teaching tool with their students.

A critical factor here, that also may be considered as part of the environmental context, is the weighing of critieria used by faculty when they consider employing technology in their teaching. Keig & Waggoner (in press) argue that disincentives exist that deter faculty from pursuing activities, like the use of technology, aimed at improving their teaching; pertinent among these are the amount of time required and institutional incentives and rewards. These factors need to be mitigated, if not overcome, in order to realize the potential benefits there may be for the use of technology in teaching.

Conclusion

Since preparation of teachers is a responsibility that extends beyond the field of education to the numerous disciplines across our campuses, it is imperative that our ideas about integrating technology into teaching become more sophisticated to include disciplinary distinctives that may come into play. The model presented here is one attempt to create a construct which may guide further inquiry in this area by examining the interrelationships of the structure and ethos of a discipline, preparation for and experience as a teacher, faculty assumptions about students, faculty attitudes and beliefs about technology, and context as they influence the use of technology in teaching.

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Modern Instructional Technology and Concepts of Curriculum

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The introduction of computers and related technologies in schools has been attended by much confusion and debate as to where, when, and how their use is appropriate. For example, it is not uncommon for two excellent teachers to polarize at opposite extremes regarding Logo. One teacher considers it one of the most important educational innovations in history; the other considers it very interesting, but highly irrelevant. The appearance of recent innovations such as hypermedia, multimedia, and related digital technologies have served to further exacerbate this situation, as has the revitalization of alternate concepts of instruction under new nomenclature such as "constructivism", and "cooperative learning." However, much of the confusion and debate surrounding modern instructional technology can be viewed as reflective of the differences among varying models for conceptualizing curriculum. Certainly, the teachers portrayed above are approaching Logo from different perspectives on curriculum. In understanding the varying concepts of curriculum one can achieve a broad perspective on technology-based practices or purposes that appear to be in conflict. The purpose of this paper is to describe five different curriculum concepts: the classical conception, the cognitive processes conception, the personalized conception, the social relevance conception, and the technological conception; and then to describe how computers and related technologies can be seen to serve each of them.

Conceptions of Curriculum

Eisner and Vallance (1974), McNeil (1985), and Purdom and Purdom (1992) identify different conceptions of curriculum that are similar enough to be synthesized as follows.

The Classical Conception

Also known as academic rationalism, this conception of curriculum is concerned with communicating to learners the greatest knowledge of civilization. Hence, it has a strong focus on the teaching of "proven" or "classical" subject matter such as logic, mathematics, Shakespeare, or Latin. The role of the teacher is to organize the information and then to transmit it, typically via lecture. Evaluation tends to take the form of written examinations and term papers that require the student to recall or to use the newly-acquired knowledge.

The Cognitive Processes Conception

The purpose of the cognitive processes curriculum is to develop problem-solvers. This conception purports to be value-free, focusing on the refinement of intellectual skills that are applicable to any field. It embodies the basic tenet of faculty psychology: the mind is a "mental muscle" that can be developed through arduous exercise. The role of the teacher is to pose interesting problems for learners and to assist them in the analytical process.

The Personalized Conception

Sometimes called humanistic, this conception of curriculum holds as its highest value the importance of individual well-being. In this conception, each learner should have satisfying experiences that lead to maximum personal development. The term whole child education is often associated with the personalized conception. Emotional and social development are valued as highly as academic development. The role of the teacher is to facilitate each learner in setting personal goals and pursuing them.

The Social Relevance Conception

For this conception, the needs of society are the highest goals—and education is the means to realize them. In the adaptive version of this conception, instruction for each individual occurs only in the context of preparing that person to be able to contribute to the larger social structure. This conception also has a reformist version, which has a stronger focus on fostering social change. In this version, the role of the teacher is to identify social problems and to facilitate inquiry into those problems by a democratic community of learners.

The Technological Conception

The technological conception of curriculum is very different from the preceding four conceptions because it is concerned mainly with the processes of teaching and learning, as opposed to the content to be delivered. Based on the findings of research in behavioral science, in this approach goals are subdivided into subtasks and subtasks are stated as behavioral objectives, all ordered in a hierarchy. A learner is diagnosed with regard to this hierarchy, receives appropriate and individualized instruction, is evaluated and retaught until mastery is achieved, and then progresses to the next task. Often, the teacher/student ratio is too low for this level of individualization, so instructional materials may include self-instructional modules, programmed texts, audiotapes, study packets, filmstrips, and computer-assisted instruction. The role of the teacher is to manage the entire process. Often, this management process is also augmented with technological means such as tracking of student progress and production of reports. Although proponents of the technological conception argue that it is appropriate for the delivery of any content, it is usually the classical curriculum that is implemented (Purdom and Purdom, 1992.)

Modern Instructional Technology in the Context of Curriculum Conceptions

The presentation of curriculum conceptions made above is an extremely brief summary. The interested reader is encouraged to consult the original sources. The remainder of this paper is devoted to how modern instructional technology can be viewed through the filter of each of these curriculum conceptions.

Technology and the Technological Conception

Instructional technology as a discipline predates computer, videodisc, CD-ROM, and other resources that have become the foci of modern instructional technology. As explained above, the "technology" referred to was a process, a systematic, scientific approach to developing and implementing instruction. Although it often sought to make effective use of technologies then current, it was primarily the process that defined the approach.

Although it began to develop with mainframes and minicomputers, the era of modern instructional technology effectively began with the arrival of microcomputers in schools around 1978. Early enthusiasts, excited with the prospect of having mainframe power at the desktop level, readily adopted another mainframe development, the vision of computer-as-teacher. It is not unfair to say that this vision, with its focus on tutorial and drill and practice, grew out of the behaviorist tradition in education (Favaro, 1986.) This was the CAI paradigm — the one in which the computer was seen as an ideal teaching machine. Computer technology was accepted as a versatile platform for assessing student knowledge, delivering individualized instruction, providing appropriate feedback, evaluating student outcomes, and all the other hallmarks of the technological conception of curriculum. (The game/simulation/ problem-solving model, which also grew out of the CAI tradition, will appear later in the discussion of the cognitive processes conception.)

As new technologies have emerged, they have fit right into this framework. First, sequential videotape, and then later, random-access mass storage media such as videodisc and CD ROM allowed a dazzling array of sounds and images to be incorporated into instructional sequences to make them more impressive and, hopefully, more effective. In the near future, telecommunications and distance learning resources promise to allow such instruction to be delivered right in the home or office. It should not be surprising, then, that technology in education continues to be viewed most commonly (especially in the popular media and by non-educator laypersons) in the context of the technological conception.

The technological conception of curriculum, at least as it applies to computer-based instruction, is currently changing. Although the behaviorist tradition continues to dominate the design of computer-based instruction (Hannafin and Hooper, 1993), the emergence of hypertext and hypermedia as instructional metaphors is resulting in a new type of software that is more consistent with a cognitive approach. Metacognition, the learner's process of monitoring and making decisions about his or her own learning, is a critical element in all well-designed hypermedia because of the high level of learner control that must be exercised. Possibly this trend occupies a spot in the domain common to the technological and personalized conceptions.

Technology and the Social Relevance Conception

Another early aspect of instructional technology, that of computer literacy, may appeal to adherents of the social relevance conception. The need to begin instilling computing skills in children who will be the work force of the next generation is being championed by many educators who, in doing so, are expressing an adaptive social relevance conception of curriculum. As a consequence, many schools and school systems have articulated specific computer literacy learning objectives and initiated instructional programs designed to teach such fundamentals as bootstrapping computer systems, formatting diskettes, and keyboarding. At the secondary school level, such curricula are often housed in business education programs. Many elementary schools have designated a computer literacy teacher whose job it is to teach the skills to all the students in the school, sometimes working with only one grade level each year. It is curious that such programs have often been implemented with worksheets and other paper materials — the students having no opportunity whatsoever to actually use a computer. Another major disadvantage of this approach has been that it usually results in no integration of technology with the rest of the curriculum. The classroom teachers remain uninvolved with what goes on in the "computer" room and the children see computers and related technology as just more objects to be studied.

The aspect of the literacy curriculum most consistent with the reformist vision of the social relevance conception of curriculum has probably been the group of literacy objectives concerned with legal, social, and ethical issues. Such technology-related issues as copyright, electronic theft, and invasion of privacy provide great potential for student inquiry. Study of these issues tends to provide a richer context when integrated with activities in the regular classroom, as opposed to the pull-out programs frequently associated with the other literacy skills noted above.

Technology and the Personalized Conception

As the microcomputer era was beginning, other changes were taking place in American education. The behaviorist tradition in education was waning in strength (Willis, 1993.) Other approaches, ones often seen as antithetical to the CAI treatment, began once again to come to the fore. It is important to note that each of these alternate visions always had adherents, it was just that the mainstream of attention was not focused upon them and technology was not seen as serving their agendas — indeed, adherents to those visions were often the most vocal critics of instructional technology. Among the factors leading to the revitalization of alternate instructional visions was research in artificial intelligence and its impact on the field of cognitive science, in the form of a trend known as "cognitivism." This paper is not an appropriate forum for a discussion of the ongoing debate concerning the relative merits of the behavioral and cognitive trends in educational psychology, but it is important for the reader to understand that cognitivism is often viewed as an important component of the theoretical bases for alternative instructional approaches such as constructivism, cooperative learning, and the like. In 1980, two watershed publications occurred: Papert's *Mindstorms* and Taylor's *The Computer in the School: Tutor, Tool, Tutee*. Each indicates ways for computers to be used in the implementation of such alternative approaches.

Mindstorms is the Logo manifesto and Papert is Logo's best known spokesman. Based on research in cognitive science and informed by Jean Piaget's research in child development, Logo was the first well-known application of technology to teaching and learning that broke away from the CAI model. Papert envisions Logo as a playground for discovery that allows learners to "construct" their own understandings of knowledge.

As evinced by its popularity among child-centered educators, the philosophy of Logo expressed by Papert in *Mindstorms* is strongly supportive of the personalized conception of curriculum. Implementing Logo's major theme of learning by discovery requires that learners be afforded a great deal of control over the learning process. By controlling the process and taking learning episodes in directions he or she desires, the Logo learner's experience embodies the belief that school should exist to serve the needs of the individual.

Taylor's tutor, tool, tutee framework was the first widely-known terminology that allowed educators to use language that transcended the CAI model. Taylor's framework describes learner/computer interactions in terms of locus of control, active or passive engagement of the learner, and the didactic or inductive nature of the learning experience. Learners interact with technology in the tutor mode when they use software developed in the CAI tradition. Tutee mode is engaged when the student learns by "teaching" the computer, as in Logo. Taylor's third mode occurs when the learner uses the technology as a tool to accomplish another objective. The use of a database manager to create a "Countries of the World" database with which to test hypotheses about relationships among social factors is an example of this mode. Taylor's model was adopted very quickly by many educators because it gave them a way to talk about and to conceive of uses of computers that did not fit into the CAI tradition. Both tutee and tool use of computers are very supportive of the personalized curriculum. They often occur in the context of a project-driven instructional approach in which the student has selected the goal(s) and procedure(s) of the project.

Technology and the Cognitive Processes Conception

Almost all computer programming instruction can be viewed from the cognitive processes conception of curriculum. The reason that educators teach programming is the hope that it makes learners better problem-solvers. From grade school Logo to Advanced Placement Pascal, the emphasis in programming instruction has been on the exercise of mental faculties and the development of problem-solving skills. Logo and the procedural languages such as Pascal embody in their designs the adoption of the top-down problem-solving method. Indeed, it is very difficult to accomplish much in any of these languages without using this top-down approach, which requires the programmer repeatedly to subdivide problems into increasingly smaller sub-problems. Educators hope that problem-solving abilities acquired this way are transferable to other domains, such as mathematics. Much of the research on Logo and other languages has studied such questions—albeit with inconclusive results.

As mentioned earlier, the cognitive processes curriculum must also include discussion of educational simulation and problem-solving software. There is a wide variety of software, often in a game format, that requires the student to use knowledge and problem-solving abilities to complete such tasks as: find a monster in a swamp, rule a monarchy, operate a food concession, travel the Oregon Trail, or catch an international criminal. Finding the swamp monster efficiently in "hurkle" type programs, for example, requires the learner to learn or to invent the binary search strategy. By way of further example, successfully ruling a kingdom in "hammurabi" type simulations requires the learner to make and repeatedly to revise heuristics about how many bushels of grain must be planted in order to feed the population in the coming year. Additional aspects of well-designed problem-solving and simulation software are that it can cause learners to think creatively across multiple disciplines, and that it often can be used in cooperative groups.

Technology and the Classical Conception of Curriculum

Consideration of the classical conception of curriculum brings this discussion full cycle. As mentioned earlier, the one way that the classical curriculum does relate to modern instructional technology is that it is most often the content delivered via the technological conception. As a content area, technology cannot be a formal part of the classical curriculum. However, because the computer science domain has much in common with the classical fields, it is often treated as such. It has rigor (a formal proof can be constructed to show that an programming algorithm is correct and complete), aesthetics (programming algorithms have varying degrees of elegance, and can be ugly or beautiful), and is mentally challenging. Therefore, computer science as a curriculum has become a part of the academic curriculum in many high schools. It is most often taught in a very traditional manner. The more innovative methods of using instructional technology in computer science are no more fully developed or implemented than they are in any part of the classical curriculum.

Summary

One important reason for the study of varying conceptions of curriculum is that apparent conflicts in educational practices begin to make sense if one understands the mind sets that are behind the conflicting practices (Purdom and Purdom, 1992.) Educators who understand this issue are better prepared to deal with content, method, organization, and evaluation of curriculum in their own teaching (McNeil, 1985.) In the case of modern instructional technology, the importance of these purposes can hardly be understated. Obviously, there are gray areas that lend themselves to differing interpretations. This paper has striven to identify the dominant themes.

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Using Technology: Assessment of Learner Characteristics and Appropriate Instruction

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The current reform and restructuring efforts in the last decade have brought about many approaches and models for effective teaching and student learning. These approaches and models include: cooperative learning, individualized learning, active learning, problem-solving and thinking skills, learning styles, use of manipulatives, use of technology, thematic approaches, and interdisciplinary approaches. The focus in education has shifted to the learner, recognizing their characteristics and preferences and providing appropriate instruction. Educators, however, are faced with questions that will challenge their skills, expertise and resources. These include: How can learner characteristics and preferences be identified? How important are these learner characteristics and preferences to the learning process? How can these learner characteristics and preferences be integrated into the instructional process? How can materials and technology be used to facilitate the instructional process and enhance learning for students with a variety of characteristics and preferences. Some possible solutions and/or strategies can be explored.

Learner Characteristics—Impact and Identification

The field of education has always acknowledged the existence of learner characteristics and preferences but there have been few successful attempts to adequately provide for students in typical classrooms in this country. The problems associated with these attempts include class size, appropriate instructional strategies, appropriate resources, and appropriate initial and continuous assessment regarding the identification and changes in these learner characteristics and preferences. As previously mentioned, many diverse instructional strategies are now being used more frequently nationwide. In addition, instructional resources such as manipulatives, audio/visual (A/V) materials, and computer-based materials are having a very positive impact on instruction. Educators need to be able to identify special characteristics and preferences and attempt to use the appropriate instructional strategies and resources to optimize each student's learning outcomes. The issues of concern involve both assessment to identify learner characteristics and preferences and the instructional integration of the results. Assessment itself is not a primary issue. Assessments still play an important role in the learning process. In fact, many diverse assessment instruments and strategies are currently being used. These instruments and strategies include: formative evaluation, summative evaluation, portfolio assessment, and performance assessments. Recent practices tend to place less importance on standardized tests. Standardized tests have received many criticisms regarding their adequate representation of student knowledge, skills, behaviors, and experiences for specific content taught while not accounting for chronological age and their social, cultural, and racial background (Spandel and Worthen, 1991). Most standardized tests have weak relationships to the teaching-learning process and should not be used to label/categorize students, predict their performance, and dictate or restrict what is lum must also include discussion of educational simulation and problem-solving software. There is a wide variety of software, often in a game format, that requires the student to use knowledge and problem-solving abilities to complete such tasks as: find a monster in a swamp, rule a monarchy, operate a food concession, travel the Oregon Trail, or catch an international criminal. Finding the swamp monster efficiently in "hurkle" type programs, for example, requires the learner to learn or to invent the binary search strategy. By way of further example, successfully ruling a kingdom in "hammurabi" type simulations requires the learner to make and repeatedly to revise heuristics about how many bushels of grain must be planted in order to feed the population in the coming year. Additional aspects of well-designed problem-solving and simulation software are that it can cause learners to think creatively across multiple disciplines, and that it often can be used in cooperative groups.

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taught (Spandel and Worthen, 1991).

Educational tests are used in schools to achieve four purposes: accountability, selection, evaluation of educational innovations and projects, and instructional guidance (Tyler and White, 1979). Most often students are tested on academic achievement for the purpose of accountability or selection into an academic group. Unfortunately, educational tests are not used with great frequency for instructional guidance. Hopefully, a renewed interest in tests for instructional guidance will lead to recognition and acceptance for the assessment of learner characteristics and preferences. However, this can only be accomplished if the definitions, theories, importance and roles involving learner characteristics and preferences are clarified and significant research has been conducted.

The initial concern involves a definition, explanation, and examples of learner characteristics and preferences. These characteristics and preferences represent a very broad area and would include any features or attributes, learned or acquired or innate that a student brings into a particular learning environment. These characteristics and preferences may have foundation in many of the following areas: academic, interests, cultural, attitudinal, and learning styles. Many of these areas represent a large number of characteristics that are often related to other areas. Motivation alone is affected by many personal characteristics such as interest, need, value, attitude, aspiration, and incentive (Gage and Berliner, 1984). Childhood factors related to home background also affect motivation. These factors include achievement, independence, self-reliance and aspirations that have been communicated by parents and others (Gage and Berliner, 1984). Motivation problems also differ by a student's grade level/age due to immaturity or poor socialization (Stipek, 1988).

There are many ways to categorize and focus on the many learner characteristics and preferences that may significantly impact how a learner will succeed in a particular learning situation. New and existing theories continue to be researched and verified. However, learning styles theories and approaches are gaining greater acceptance due to significant research and successful results from practitioners. Substantial research indicates that the accommodation of student's learning style preferences improves the achievement and attitudes (Dunn, Beaudry, and Klavas, 1989). Perhaps these theories will be the first of many that can readily assess learner characteristics and preferences and be utilized to improve student outcomes in the classroom.

Learning style theories represent characteristics and preferences that encompass many areas. Teaching based on learning styles assumes that children have different cognitive, affective and physiological characteristics which affect their ways of perceiving, processing and learning. Learning styles include perceptual preferences (visual, auditory, and kinesthetic), orientation towards cooperation or competition, type of motivation (extrinsic, intrinsic), preferred degree of work structure (unstructured, structured) and environmental preferences such as lighting, temperature, background noise, and type of furniture (Louisell and Descamps, 1992).

This definition of learning styles reflects some of the learning style theories espoused over the last twenty years. Unfortunately, there are many others that differ in their conceptualizations and approaches. These other theories include modalities, multiple intelligences, and right/left brain dominance. The lack of consistency among many theories regarding definitions and conceptualizations have contributed to weaken the results of research findings and the direct application in educational environments (Curry, 1990). Some lack of evidence regarding the use of reliable and valid instruments used in research has also weakened research results and applicability (Curry, 1990).

Some learning style theories have been developed, researched and applied with great success in a variety of educational environments. A note of caution is needed concerning reliance on using only one learning style inventory. Like any other assessment instrument, placing reliance on the results of just one learning style inventory for all students is not educationally sound. The use of different learning style instruments is recommended, especially in light of some criticisms regarding inconclusive and inconsistent research results.

Many educators are using learning style inventories. They find them easy to administer and send away for scoring. Recently, many companies have computerized their inventories and results can be easily obtained at the actual testing location within a reasonable amount of time. The use of computers for testing brings us into the larger field of computer managed instruction (CMI). This involves many procedures, strategies, and products that enable educators to plan instructional lessons and manage/assess the progress of students. This paper will only address the CMI use of computers for assessment. However, a special note of interest needs to be made regarding a unique software package called *4mation* (by Excel Incorporated). It enables educators to utilize learning style results to plan and implement effective and appropriate instruction. The package helps teachers develop lessons for students who have a variety of learner preferences. Educators are able to improve teaching skills and improve student motivation while developing and sharing lessons collaboratively with other educators.

Utilizing Computer Assisted Testing

The advantages of using the computer to score learning style inventories is similar to the advantages of using computers for many kinds of tests. Some of the advantages over paper and pencil tests include: greater standardization of administration, improved test security, enriched display capabilities, and enhanced response alternatives (Olsen, 1990). Computerized testing also provides the capability for developing new item types, providing equivalent scores with reduced testing time, minimization of certain measurement errors, ability to measure response latencies and patterns, and immediate test scoring and organized useful reporting (Olsen, 1990).

Much research has been conducted regarding the validity and reliability of using computerized tests versus paper and pencil tests (Ward, 1984). The research primarily involved tests of academic achievement and was very favorable. Studies involving psychometric tests have also evidenced equivalent validity and reliability as compared with paper and pencil tests (Lushene, Oneil, and Dunn, 1974; Scissions, 1976; Katz and Dalby, 1981). Psychometric tests in computerized format must adhere to specific guidelines due to the nature of the tests. *The Guidelines for Computer-Based Tests and Interpretations* were published by the American Psychological Association in 1986. These guidelines help to insure validity and reliability, but critics point out concerns about the equivalency of the form and the nature of the criteria for validating computerized versions of paper and pencil tests (Butcher, 1987; Kramer, 1988).

Computer assisted testing has become widely accepted and currently is being used for many standardized tests, including such well known tests as the Graduate Record Exam and the Strong-Campbell Interest Inventory. The newer generations of tests include Computer Adaptive Tests, Continuous Measurement tests and Intelligent Measurement Tests. Computer Adaptive tests actually adapt to the examinee performance based on presentation speed, item content, item parameters and stopping rules. The additional advantages include increased measurement precision and reduced testing time (Olsen, 1990) Continuous Measurement employs calibrated, curriculum exercises or tasks which are embedded within a computerized curriculum and used to unobtrusively estimate dynamic changes in student knowledge and proficiency levels (Olson, 1990). Finally, intelligent measurement utilizes an intelligent knowledge base to perform sophisticated educational measurement tasks (Olsen, 1990). It should be noted that validity and reliability need to be significantly examined for all these computerized methods of assessment. Certain kinds of tests and individuals with certain characteristics and preferences may not have their test responses accurately interpreted by standardized algorithms and knowledge bases.

All of these forms of computer assisted testing could easily be applied to the use of learning style inventories. The higher levels of adaptive and intelligent computerized assessment would be more advantageous to the classroom educator but any level of computerization would be helpful in providing vital information about each student's characteristics and preferences in order for educators to provide appropriate instruction and resources.

Learner Profiles—Benefits and Use

The use of computers for testing at any level or mode can obviously be very beneficial to educators for making instructional decisions. However, as previously mentioned, educators need to be cautioned about using only one test to obtain an accurate and comprehensive picture of the learner. One test may not be as valid and reliable for a particular learner and may not reflect all characteristics and preferences of the learner. It should be obvious that there are a great amount of characteristics and preferences that need consideration. They range from abilities to learning styles and thus need to be assessed by several instruments. Educators can only make the best instructional decisions with accurate and complete information. Developing a profile of the student using a variety of assessments would be a logical approach. The learner profile would be very beneficial for decision-making by educators, just as psychological profiles of criminals are used by law enforcement officials.

The learner profile would be determined initially when a student takes a series of tests at a designated time and/or continuously while he/she receives instruction during the academic year. The profile would need to be printed/reported in a usable format for educators and would need to be updated periodically. Obviously these profiles would require a great amount of human time and effort to compile and update. Hence, the use of computerized assessments would be advisable.

The computerized assessment results from a variety of computerized assessment instruments could each be printed separately using each company's software or services. Results could then be combined and possibly categorized to reflect common and/or related results. A specialized computer program would need to be developed and utilized in order to obtain reports that represent this combined data about assessment results. The computerized profiles would not only save significant time and work, but would provide more efficiently organized and updated information that educators could use in order to make the most appropriate instructional decisions. Hence, use of computers to help manage instruction can be very beneficial if used appropriately.

Educators need to encourage the development and use of software which can either provide appropriate reports from results of separate instruments and then combined into a profile. The obvious first step needed would be the recognition, acceptance and use of a variety of assessment instruments that would reflect a wide range of learner characteristics and preferences.

Instructional Roles—Computers and Related Technologies

The educators in this country are increasingly using computers and related technologies for instructional delivery and the management of instruction. Some of the effective uses of computers for management have already been discussed. However, the instructional decisions that will be made by educators after determining learner characteristics and preferences is critical. Educators need to provide appropriate instructional activities/experiences which will accommodate and/or strengthen students characteristics and preferences. Those activities/experiences will need to incorporate appropriate instructional strategies and resources. Obviously, the computer and other related technologies are becoming excellent resources for educators. They present academic content using a variety of instructional strategies. The software being developed currently also addresses students diverse characteristics and preferences. Students that demonstrate visual or tactile or auditory preferences, for example, can benefit from computer software that presents content in all of those formats. Recent developments in computer-based multimedia materials also represent instruction applicable to students having various learning styles (Carlson, 1991).

Computers and related technologies are also being used for instruction and management simultaneously. Intelligent Computer Assisted Instruction (I.C.A.I.) reflects one such combination. The software has been developed to determine student needs and then utilize the knowledge bases of content and instructional strategies to provide the most appropriate instruction to the learner (Burns, Parlett, and Redfield, 1991). Concerns expressed by educators involve the degree of control of computer software and whether appropriate instructional decisions are being made. Future development of such systems would need to thoroughly investigate the knowledge bases used and the algorithms used. Most certainly, educators should encourage such systems to incorporate knowledge bases and algorithms related to varied learner characteristics and preferences. This certainly would enable more accurate instructional decisions to be made.

The use of computerized learner profiles could also be incorporated into I.C.A.I. systems and thereby enable more accurate instructional decisions to be made. The I.C.A.I. systems may be a few years in coming, but there is no reason why educators cannot start utilizing computerized assessment results for providing instructional activities/ experiences which include the use of excellent computer-based materials.

Description of some Instruments

The use of computerized assessment tools are a first step for potential benefits. The remainder of this paper will present the features of a few assessment tools. These include:

E-LASSI (by H and H Publishing)
A Computer Assisted Testing instrument which measures student behaviors and attitudes towards learning and studying. Ten scales are used: attitude, motivation, time management, anxiety, concentration, information processing, selecting main ideas, self testing, and test strategies.

Student Survival (by Personal Style Publishing)
A Computer Assisted Testing instrument which gives feedback to first year college students regarding areas that influence achievement 1) Learning Styles 2) Study Skills 3) Time Management 4) Career Development.

Learning Styles (by Education Information Systems)
A Computer Assisted Testing instrument that identifies a student's learning style and then suggests strategies to improve the way they learn.

Max Inventory of Learning Styles (by Intellimation)
A Computer Assisted Testing instrument that is based on right-brained, left-brained research and multiple intelligences research . It uses visuals, sounds, and text to suggest alternative learning styles for students and teachers.

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Assessment Measures for Hypermedia: Development of the IAHK

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Hypermedia no longer requires a detailed introduction. The integration of multimedia and hypertext forms a technological learning environment capable of providing learners with a nonlinear approach to education that has many recognized advantages. The associative nature of hypermedia provides an arena in which learners can "jump" to new ideas that are conceptually and/or contextually related with the ease of clicking a mouse or pressing a key.

The use of hypermedia in education involves three fundamental applications—knowledge presentation, knowledge representation, and knowledge construction (Nelson, 1993). Knowledge presentation refers to the vast amount of information available to the learner within a hypermedia environment. Knowledge representation refers to the design of hypermedia programs: the metaphorical comparison to cognitive psychology's proposed models of memory in which information is linked in individually meaningful ways. Knowledge construction refers to the learner's ability to establish his or her own networks of information from operating within such an information-rich environment. This construction can also refer to students' developing their own hypermedia programs for which they decide how concepts and relationships are arranged for the proposed "learners" who will use the software.

Teacher Education and Hypermedia

Not only do prospective teachers need to be content-area experts, but they also need to be expert instructors as well. Because of this dual-role responsibility of teachers, teacher education often requires instruction that is able to "cut across" the content areas. As a tool for educators, hypermedia can help to alleviate this dual-role dilemma by (a) providing content-area expertise and information and (b) serving as a professional delivery system based on sound instructional design principles. The different content areas in which hypermedia has been applied include (a) earth science (Barba & Armstrong, 1992; Levin, 1991); (b) political science (Janda, 1992); (c) science education (Marsh & Kumar, 1992); (d) second language learning (Liu & Reed, 1993); (e) cell biology (Hall, Thorogood, Hutchings, & Carr, 1989); (f) history (Crane & Mylonas, 1988); and (g) social studies (Horton, Boone, & Lovitt, 1990). Scheidler (1993) and Reed and Rosenbluth (in press) explain how hypermedia can be used to "cut across" the content areas by using hypermedia as a multidisciplinary tool—that is, multiple content areas are addressed through student constructions of hypermedia programs. Not all applications for hypermedia are reserved to the content areas, however, since hypermedia has also been applied specifically within teacher education (Fitzgerald, 1992; Martorella, Barton, & Steelman, 1991; Romance & Vitale, 1991).

Although there are numerous studies that have examined the effects of learning *with* hypermedia in the different content areas, few studies have examined learning *about* hypermedia as its own area of content for prospective teachers. The current rate of technological advancements, the popularity of hypermedia-assisted instruction (HAI), and the proven effectiveness of HAI require that preservice teachers be introduced to hypermedia-based applications, particularly within education, so that this instructional medium will be used most effectively. Learning *about* hypermedia then creates the dilemma of effective measures to quantify changes in hypermedia knowledge. There is practically no available literature that examines comprehensive assessment measures for general hypermedia knowledge for both learning *with* and learning *about* hypermedia. This paper will begin to fill this void.

Hypermedia is such a rich environment that simply measuring changes in learner performance fails to target the uniquely hypermedia-like advantages of incidental knowledge, higher order thinking skills, and the organizational structures of knowledge. There is a need for assessment measures that target knowledge of hypermedia systems and features as they are applied within an educational environment. Although paper and pencil measures recognizably have limitations, they have long provided a valuable source of data for educators and students. They do not, however, provide a total picture. In pursuit of this more "total" picture, we chose to use multiple methods for implementing these assessment measures within our curriculum.

The focus of learning *with* HAI has yielded hypermedia-based measures to analyze and evaluate the student's (in our case preservice teachers) actual decisions throughout a period of HAI using audit trails, keystroke mapping, macros, and algorithms that can recreate the learner's chosen path through hypermedia-presented information. These measures are particularly effective at revealing *where* a student has chosen to travel as he or she navigates through the HAI environment. Of the three recognized uses of hypermedia—knowledge presentation, knowledge representation, and knowledge construction (Nelson, 1993)—these measures provide insight specifically into information as it is *presented* to the learner. Although these techniques have proven effective for this purpose, there is also the need for more global assessment methods to explain other information as it relates to learning in the HAI environment. Equally important is to develop an understanding of a student's more general knowledge in order to provide clues as to *why* the student may have made these certain choices.

Learning *about* hypermedia can begin to target students' knowledge *representation* as they ponder and philosophize the theoretical underpinnings of HAI. Deciding between competing mental model definitions to determine one's own structure of knowledge and recognizing the many representational possibilities within a hypertext programming environment are both methods of encouraging students to enhance their own knowledge representations. To better understand this structural knowledge of a learner requires operationalizing these inherently internal processes so that they are more readily visible to others. Methods of graphically depicting these organizational frameworks are available through *concept maps* and *semantic networks*. Using both paper-and-pencil and computerized concept map exercises, we were able to gain insight into preservice teachers' structural knowledge of hypermedia-related concepts.

Requiring students to develop their own hypermedia software programs can begin to enhance their *construction of knowledge*. Comparing students' responses on a concept mapping exercise before, during, and after a course on hypermedia can begin to reveal information about knowledge construction. Therefore, developing one's own software involves both learning *with* and learning *about* hypermedia.

Types of Assessment

There are many different types of assessment. *Formative* assessment is intended to provide insight into student progress, and the instructional strategies used, in an ongoing fashion. When used effectively, formative assessment provides frequent feedback allowing students and instructors to take corrective action in a timely manner. *Summative* assessment is more long-range and is intended to provide end-of-course information relative to the learner's mastery of the subject matter and administrative information for evaluating the effectiveness of the curriculum. There are distinct differences between evaluation—used to describe the value or worth of a particular program—and assessment—used to describe individual student's abilities and achievement. In this paper we have chosen to reserve the term "assessment" for the discussion of learners' academic progress.

Traditionally, assessment has taken the form of paper-and-pencil measures. Within a hypermedia learning environment these measures fall short of capturing a complete picture of the student's progress. Alternative forms of assessment have been proposed that target more comprehensive and realistic views of a student's progress—portfolios, journal entries, progress logs, oral discussions, and learner-created materials (Cates, 1992; Shore, 1993). These measures are capable of providing authentic opportunities for learning experiences while also providing a product that can be used for assessment. Computer-based assessment methods have involved audit trails (Misanchuk & Schwier, 1992; Nelson, 1993; Wang & Jonassen, 1993), keystroke mapping (Bonk & Reynolds, 1992), and computerized testing (Palumbo & Reed, 1988).

Audit trails provide a record of a learner's responses that are made while engaging in hypermedia instruction. Essentially, they provide a record of where the learner has chosen to travel by generating a navigational re-creation of these learner choices. It may be beneficial for the instructor interested in using this means of assessment to realize that it generates an enormous amount of data for even a single student's instructional travels. A possible advantage of this method is that it is transparent to the learner since the computer captures the student's choices "behind the scene."

Keystroke mapping involves recreating learner choices by having the computer record the learner's keystrokes as macros so that they can be played back for analysis. Similar to audit trails, keystroke mapping provides a method for examining where the learner has chosen to travel.

Computerized testing can involve using the computer to score paper and pencil tests or using the computer to administer and score the test. Advantages of using the computer are obvious since scoring tests by hand is often tedious. Advantages of using the computer to administer the test may be less apparent—scheduling of the test can be done individually rather than waiting until the class has come together and feedback can be immediate. A disadvantage of this method of assessment is the expense involved and the fact that the question format is often no different from paper and pencil measures—true/false, multiple choice, short answer, etc.

Of the alternative forms of assessment that have been proposed—portfolios, journal entries, progress logs, oral discussions, and learner-created materials—we chose several of these methods for use as assessment measures within our course of Hypermedia in Education. Individually each of these methods alone lacks the ability to provide a complete picture of the student's progress, but when used collectively they provide an aggregate view of the student. Feeling that even these methods when used collectively lacked the means of (a) rating a student's initial level of knowledge, (b) the capacity to group students, (c) assessing general hypermedia knowledge, and (d) measure changes related to hypermedia instruction, we developed an instrument to achieve these goals of assessment—the IAHK.

Instrument for the Assessment of Hypermedia Knowledge

The IAHK has been developed as one method of determining students' levels of expertise with hypermedia. The instrument is designed to determine differences in hypermedia novices and users of hypermedia with more advanced levels of skill. Given the limitations of paper and pencil measures, the instrument is not purported to measure all aspects of hypermedia knowledge but is useful in determining change in hypermedia knowledge. Reed, Ayersman, and Liu (1993) found that the instrument successfully measured preservice teachers' changes in hypermedia knowledge as a result of instruction *about* hypermedia which often included instruction *using* hypermedia. As a result of a semester-length hypermedia course, there was a significant increase from pretest to posttest ($t\,[14] = -9.39$, $p < .0001$).

This instrument—the IAHK—is not being touted as a comprehensive measure of hypermedia skills, but when used in conjunction with other measures (some of which have been mentioned) it is effective at measuring hypermedia knowledge (Reed, Ayersman, & Liu, 1993). It is effective for determining students' levels of expertise with hypermedia which is useful for determining their needs for instructional purposes. Essentially, this instrument provides information that can be used for grouping students, measuring change related to hypermedia instruction, or assessing general knowledge of hypermedia. The instrument has reached acceptable levels of reliability with alpha coefficients of .75 and .92.

The IAHK is a paper and pencil measure consisting of 32 items and includes seven short answer questions, 14 matching, five multiple choice, and six true/false questions. Possible scores on the instrument range from 0 to 46 with the short answer questions being more heavily weighted than the other items of the instrument.

To better define the concept of "hypermedia knowledge," we conducted a domain analysis of the instrument. The 32-item *Instrument for Assessing Hypermedia Knowledge* reflects six hypermedia knowledge domains: (a) hypermedia theory, (b) hypermedia software, (c) general hypermedia definitions and information, (d) hypermedia applications, (e) hypermedia information structure, and (f) hypermedia processes. The domain *hypermedia theory* (five items) assesses students' understanding of the four mental models associated with hypermedia learning environments: (1) the hierarchically structured semantic network, (2) the nonhierarchically structured concept map, (3) the static and familiar frame and script, and (d) the user-developed schema. The domain *hypermedia software* (five items) measures their knowing such hypermedia devices as CD-ROM, CD-I, DV-I, CAV, and CLV. The *general hypermedia-related definitions and information* domain (seven items) is represented by items that measure their understanding of the terms hypertext, hypermedia, and multimedia. The students' understanding of *hypermedia application* (six items) is measured by the various forms of hypermedia use (knowledge presentation, knowledge representation, and knowledge construction). Their understanding of *hypermedia information structures* (three items) is assessed by such terms as nodes, links, and design principles. Finally, their knowledge of the domain *hypermedia processes* (five items) is evaluated via such terms as learning, navigation, cognitive overhead, and lost in hyperspace.

When we developed this instrument, we chose not to excessively rely upon it for our sole source of information about students' hypermedia knowledge. We chose to also use other measures that targeted both cognitive and metacognitive changes allowing us to gain an aggregate look at the students' progress. The preservice teachers were asked to maintain weekly response logs which allowed them to record questions or points of interest about the readings. Oral discussions were conducted weekly that allowed them to present ideas from their response logs to the class and the instructors. Printed copies of these response logs were turned in to the instructors so that they could respond to the points of interest or confusion raised by the preservice teachers. These response logs were then categorized based on a list of 30 nouns from Bloom's taxonomy of cognitive levels. These responses were categorized initially by the preservice teachers themselves to promote reflection and self-appraisal and then later categorized by the instructors to ensure accuracy. Other data were collected pertaining to student attitudes toward hypermedia that also contributed to the aggregate view of student change resulting from the course experience.

Conclusion/Discussion

To determine the effectiveness of HAI requires new forms of assessment which target more than simple recall and recognition of information because these measures represent only a portion of the learning potentially involved in HAI environments. These new assessment procedures should incorporate both formative and summative evaluation measures not only to demonstrate the effectiveness of the hypermedia training materials but also to provide guidance in designing and producing more effective hypermedia training materials in the future (Harvey, 1993).

Rather than rely on a single generalizable tool for measuring the broad category of hypermedia knowledge, perhaps the focus should be on locally produced instruments that are effective at measuring cognitive change for those specific students involved. Because of the inability of paper and pencil measures to adequately encompass the total picture of student abilities and the limitations of computerized evaluative measures, multiple forms of assessment should be used. Students' familiarity with paper and pencil measures creates some consistency within an otherwise technological world of CD-ROMs and laserdiscs.

Clearly, no single method is best suited to providing evaluative data on a student's proposed learning, particularly within a hypermedia environment. An innovative combination of these methods can effectively target those characteristics that are collectively representative of one's learning. This paper presents one possible combination.

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World Literacy: An Alternative for the Schools

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As we quickly move into the next century disenchantment with our schools mounts. There is a plethora of criticism coming from almost every quarter of our society. The common conclusion is that the schools are not doing their "job." The target of the critics may center around the deficiency of basic skills among our students or the inadequacy of the knowledge they reveal about basic topics, such as history, geography, or science. Or, critics may focus on the lack of engagement of the student in the educational process itself. In other words, few are pleased with the impact of the schools on its students.

We offer in this brief essay a diagnosis of what might be amiss in our schools and more importantly we offer a prescription for what might bring about significant change in the way the schools educate. We will use the perspective of Neil Postman in analyzing the present societal condition.

Many commentators on the contemporary scene have noted deep changes in American and Western society. David Harvey (1989) in his perceptive book, *The Condition of Postmodernism* talks of a "fading of unified Enlightenment beliefs" (p. 31) that once guided and directed our culture. Where once we agreed upon a foundational set of beliefs buttressed by the authority of tradition, reason, and rationality we find in its place a plurality of perspectives.

Neil Postman (1985) talks about this in his discussion of the displacement of the written tradition. Postman finds that there is a transition from the school's emphasis on traditional written literacy embodied in "the book" to that of the television culture. The shift brings with it epistimological concerns. With the written culture, continuity with the past was insured. Reading itself promoted rationality.

As Postman put it:

> From Erasmus in the sixteenth century to Elizabeth Eisenstein in the twentieth, almost every scholar who has grappled with the question of what reading does to one's habits of mind has concluded that the process encourages rationality; that the sequential propositional character of the written word fosters what Walter Ong calls the 'analytic management of knowledge.' To engage in the written word means to follow a line of thought, which requires considerable powers of classifying, inference-making, reasoning (p.51).

With the emergence of the television culture the habits of mind turn to an "everpresent tense." The past, therefore, becomes irrelevant and only the present as represented through pictures and sounds are important. Postman (1985) believes that the ability to sustain attention and self-directed thought become casualties with this medium; entertainment and distraction become keenly sought.

In *Teaching as a Conserving Activity* (1982), Postman viewed the competing mindsets in a dialectic fashion. To Postman, the school should represent traditional literacy and the habits engendered by reading against the dominant culture of television and instant gratification. He even held fast against bringing the medium of television into the classroom, since by its very nature it subverts the qualities of mind that education should nurture.

Television is, of course, but one cause in what is referred to as the postmodern temperament. But what is clear is that there is a great number of students who reveal the postmodern mindset: the willingness to live in a reality of pluralism, fragmentation, and ephemeralism. To such a mindset, today does not resemble tomorrow, therefore the wisdom of the present is not a reliable guide to the future. There are many voices speaking rather than one authoritative voice. Accordingly what occurs in schools seems shadowy and unreal.

Society has changed, its students have changed, while the school has been clinging to a narrow ledge of the past. We are more than sympathetic to the habits of mind developed by the tradition of literacy, but the schools cannot force feed literacy by its present methods. We realize that once literacy is attained by the student it provides an enormous power for dealing with life. The question becomes one of whether to continue a practice that is no longer working or to introduce a new way that engages students in a more promising educational process? It may well be that many students whg reveal short attention spans choose this behavior as a way of dealing with an irrelevant educational setting.

The answer to the preservation of literacy while at the same time engaging the student is to enlarge the idea of literacy into emerging educational technologies. Literacy would then be viewed, not as an opponent of technology, but rather as a vital part of a new world literacy process. The computer and interactive technology hold an immediate promise of placing the student in an active position of developing intellectual control. Computer and interactive media empower the student to reach beyond his classroom to areas of concern and interest. Like the traditional library, it unlocks worlds and encourages active exploration. What is compelling about this new world literacy is that it permits the student to work directly upon the world, to learn about it and even affect it. Written works, texts, and books will be enlivened as a part of a living search. Students will read Shakespeare interspersed with enacted scenes from his plays. They will look at a masterpiece from the Louvre while reading what a perceptive critic has discerned about the painting. They will see the ground where the Battle of Hastings was fought while reading about its events. They may even offer strategies to the unfolding battle and see the effects as events play themselves out. The student becomes thus both a witness to the actual or reproduced referents in a written text and an active player in the dramas of the world. In the process the student learns ways of discovery and understanding through rich connections to multiple sources.

The habit of mind that is most nurtured by the process of world literacy is a progressive and unrelenting probing of various phenomena to expanding patterns of meaning. Such habits of mind transfer well beyond school. They induce an appreciation of the connections of the immediate and present to the far and the past. Moreover, they provide the individual with ways of continuing his education.

Bringing world literacy into the heart of the school curriculum would require radical changes in the current generation of teachers and in the way we prepare the next generation. Technically competent teachers, who are aware of, and able to use, the power of information technologies, would certainly be one necessity. Technical competence would not, however, be a sufficient condition. For many educators, a change in foundation beliefs and assumptions about education and its role in society would also be required. That would include alternative philosophies of education, epistemologies, theories of learning (for both children and professionals), and theories that help define the role of education in society.

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Instructional Screen Design Using Gestalt Theory

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From the solitary student sitting in front of a computer tutorial to a group of students looking up at the information presented using an LCD panel, learners are exposed to screens of information which are supposed to help them learn more effectively. Gestalt theory helps develop a method of planning presentation elements to help viewers learn more effectively. This is particularly true when one considers how important visual perception is during a multimedia presentations because visual perception in learning is explained by Gestalt theorists.

Two major aspects of Gestalt theory can help guide screen design. The Laws of Perception explain how individuals perceive and organize their auditory and visual fields. These laws explain how the individual organizes fields from the environment (Koffka, 1935). Another aspect to the theory which can aid in screen design is the proposition that individuals learn most things by understanding the meaning of the underlying progression of parts (Bower and Hilgard, 1981). Koffka (1935) stated that information was easier to learn when individuals could understand it and form bridges with previous information. New information is organized and connected to previous information to form an organized whole. This organized whole is often called a Gestalt.

Both multiple screen and single screen designs can be guided by Gestalt principles. While single frame design will be discussed here, it should be mentioned that Gestalt theory can guide the arrangement of a frame series to aid individuals in the development of concepts. Longstreet (1992) suggested that conceptual insight can be aided by creating an organized series of frames. This series of frames should provide students with a clear pattern in order to facilitate learning a particular concept. The pattern formed by these frames would provide the learner with a Gestalt. When a series of frames is used to create a Gestalt it can be called *between* frame design. Between frame design is guided primarily by that portion of the theory which addresses the individual's attempt to make sense of the world by connecting information to create a Gestalt.

What will be discussed here is *within* frame design. Within frame design is primarily based upon the Gestalt Laws of Perceptual Organization. According to Kohler (1947) and Koffka (1935) visual fields are organized into visual patterns that are grouped according to Laws of Perceptual Organization. These laws involve: figure-ground relationships; proximity; similarity; common direction; and simplicity. When seeing a whole field as in the case of a screen projected from the computer using an LCD panel, the viewer remembers information based upon how the information is perceived and organized.

Design Principles: Text

Gestalt perceptual laws can help us decide how text should be presented on the screen. The current technology allows us to animate text, change colors, change fonts, flash words, underline, highlight words and phrases, and alter text size. According to Gillingham (1988) and Longstreet (1988) this technology can hinder or aid learning.

Television is, of course, but one cause in what is referred to as the postmodern temperament. But what is clear is that there is a great number of students who reveal the postmodern mindset: the willingness to live in a reality of pluralism, fragmentation, and ephemeralism. To such a mindset, today does not resemble tomorrow, therefore the wisdom of the present is not a reliable guide to the future. There are many voices speaking rather than one authoritative voice. Accordingly what occurs in schools seems shadowy and unreal.

Society has changed, its students have changed, while the school has been clinging to a narrow ledge of the past. We are more than sympathetic to the habits of mind developed by the tradition of literacy, but the schools cannot force feed literacy by its present methods. We realize that once literacy is attained by the student it provides an enormous power for dealing with life. The question becomes one of whether to continue a practice that is no longer working or to introduce a new way that engages students in a more promising educational process? It may well be that many students who reveal short attention spans choose this behavior as a way of dealing with an irrelevant educational setting.

The answer to the preservation of literacy while at the same time engaging the student is to enlarge the idea of literacy into emerging educational technologies. Literacy would then be viewed, not as an opponent of technology, but rather as a vital part of a new world literacy process. The computer and interactive technology hold an immediate promise of placing the student in an active position of developing intellectual control. Computer and interactive media empower the student to reach beyond his classroom to areas of concern and interest. Like the traditional library, it unlocks worlds and encourages active exploration. What is compelling about this new world literacy is that it permits the student to work directly upon the world, to learn about it and even affect it. Written works, texts, and books will be enlivened as a part of a living search. Students will read Shakespeare interspersed with enacted scenes from his plays. They will look at a masterpiece from the Louvre while reading what a perceptive critic has discerned about the painting. They will see the ground where the Battle of Hastings was fought while reading about its events. They may even offer strategies to the unfolding battle and see the effects as events play themselves out. The student becomes thus both a witness to the actual or reproduced referents in a written text and an active player in the dramas of the world. In the process the student learns ways of discovery and understanding through rich connections to multiple sources.

The habit of mind that is most nurtured by the process of world literacy is a progressive and unrelenting probing of various phenomena to expanding patterns of meaning. Such habits of mind transfer well beyond school. They induce an appreciation of the connections of the immediate and present to the far and the past. Moreover, they provide the individual with ways of continuing his education.

Bringing world literacy into the heart of the school curriculum would require radical changes in the current generation of teachers and in the way we prepare the next generation. Technically competent teachers, who are aware of, and able to use, the power of information technologies, would certainly be one necessity. Technical competence would not, however, be a sufficient condition. For many educators, a change in foundation beliefs and assumptions about education and its role in society would also be required. That would include alternative philosophies of education, epistemologies, theories of learning (for both children and professionals), and theories that help define the role of education in society.

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The first Gestalt perceptual law that can aid in this decision making is the figure-ground law. The text should be clearly defined in relationship to the screen background. This should be used to inform the background color and foreground colors chosen. Text must be clearly seen to be understood. While many colors are available for use; care should be taken in choosing colors that have clear contrast between them. For example a red background with pink letters would be a poor choice because the background and foreground (the image or form on the screen) visually merge.

The figure-ground law also suggests font type and size. Screen letters are formed using pixels. Some fonts become blurred when they appear on the screen because of the spaces between pixels. When fonts with small spidery letters (fonts which have extremely thin lines) are used, decoding the letters hinders understanding because they merge into the background just as pink letters fade into a red background. This also indicates that clear sharp lines should be used for fonts and spacing between letters and lines should be such that there is clear letter definition. Clearly defined letters and words allows the viewer to see differences and decode the words without the added burden of decoding letters first. Since in Gestalt theory the individual interprets what is viewed according to prior experience, if the letters are not spaced appropriately and/or are poorly formed the individual letter interpretation may not be possible. For example, if we look at "c—l" we tend to fill in the blanks. The blanks may be interpreted as cool, coal, or caul. We have the tendancy to see what is connected to our memories rather than what the word may actually be. This is especially true when the letters are not clearly formed.

What about flashing, animated text, and color? When using Gestalt principles these techniques can enhance learning because according to Kohler (1947) the reconstruction of information can be aided by directing attention to specific items in a visual display. With text of one size, color, and font on a screen no one element will be different from another. This is explained by the law of similarity. Visual field elements will be viewed as a whole unless some elements are different. We can aid the student by using different colors to indicate key words and phrases. When color is not available, underlining, boxing the word or phrase, or changes in font or size of letters accomplishes the same thing. Flashing text is also appropriate if the flashing gains attention then stops once attention is called to it.

Text organization is also important if the student is to retain screen information. The law of proximity suggests that when information related to two concepts is presented on the same screen, the information related to each concept should be placed together, so that the information is perceived as related and therefore grouped together in the visual field. This helps the student to chunk the information for easier recall by associating the concept name with its attributes.

Design Principles: Graphics

Illustrations and animation are often used in screen presentations. How these are perceived can affect how well the student learns the material. In some cases, graphics can be distractions that hinder learning or misguide the student (Longstreet, 1988; Hannafin & Hooper, 1989). When using illustrations and/or animation the visual input should reinforce what is to be learned or give conceptual information that can aid the learner in building an accurate understanding of the material. Pictorial information that is well organized can aid the learner when recalling information later. As with text the Gestalt Laws of Perception can guide the use of illustrations and animation.

The figure-ground relationship should be clearly defined so that the majority of learners will interpret the illustration in a similar way and without ambiguity. We have all seen drawings that can either depict one thing or another, for example, the faces or vase drawing. The first time we see the picture we may see a vase. If this is the case and we see the same drawing again but perceive it as two faces, we will not remember the first viewing as a vase. It is important to note that the learner will focus on what he or she perceives as the foreground (main picture) of an illustration, so that the attention in design should be given to the foreground and that the foreground helps clarify or illuminate the material to be learned. If an instructional illustration is ambiguous in this way it can hinder learning. When the figure and ground within an illustration can be reversed and depict a subject other than the one desired for instruction, it should not be used. Clear illustrations should be used. Just as text needs to be clear to the learner, so do the illustrations.

The law of proximity also suggests that related items should be located closer together than non-related items. A simple example would be a screen in which both vegetables and fruits are shown to young children. Vegetables should be placed in a group separate from fruits. According to this law when things are placed closely together, the individual's perception recalls the members of the group more accurately.

Illustrations and animation should clarify or depict the concept or subject addressed by the text in order to help the individual learn the desired material. Since Gestalt theory supports the idea that individuals organize information in order to retrieve it from memory later, the use of graphics should connect to the written or auditory information to create a whole or Gestalt.

Animation should clarify or illustrate what is to be learned. If the learner is paying attention to an animated sequence, the information contained in that sequence will be recalled because the motion draws the individual's attention. Since this is the case, superfluous animation can hinder learning because the individual will recall it rather than the information desired. As can be seen when the law of simplicity is applied the individual will attend to those features which are dissimilar from the whole which explains why the individual will attend to the motion and remember it. *Directive animation* should be used. Directive animation illustrates a concept by using pictures and motion. Animation which does not directly show an important element of the instruction should not be used because it will interfere with the retrieval of the desired information at a later time.

Gestalt theory should be drawn upon to inform screen design so that instruction using computers for solo tutorials or for group instructional presentations can be more effective. With careful planning screen designs can be more supportive of the learning desired. A checklist is provided to aid the review of within frame screen design.

Within Frame Screen Design Checklist

Text

1. Background and foreground colors have good contrast (figure-ground)
2. Clearly formed letters (figure-ground)
3. Spacing between letters facilitates letter clarity (figure-ground)
4. Spacing between words and lines facilitates separation of words and lines (proximity)
5. Important terms and phrases are highlighted by use of underlining, color difference, font difference or size difference (similarity)
6. If flashing is used to draw attention to a term, it is for a short period (similarity)
7. Related terms are grouped together (proximity)

Graphics

1. Illustration(s) are unambiguous (figure-ground)
2. Like items are grouped together (proximity)
3. Illustrations and animation support written or auditory information (Gestalt formation)
4. Directive animation is used (Gestalt formation)

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THE COURSE

The Educational Computing Course

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For many years the stand-alone course was*the* only exposure preservice teacher eductation students had to computers and related technologies. In many colleges of eduction that is, in fact, still the case today. The papers in this section are, however, a reflection of the changing nature of educational technology courses designed specifically for teacher education students. Two papers, one by Brownell and Brownell and one by Burson and Willis, do discuss stand alone courses. The Burson and Willis course, taught at the University of Houston, is a generic course in the tradition of required educational computing courses. The Brownell course, taught at Bowling Green State University, is, on the other hand, a more specialized course that was created specifically for secondary education majors. We are likely to see more and more of these specialized courses. Even in the generic University of Houston course there is an effort to customize the course to the career plans of each student.

Other papers in this section address issues that are at the heart of any effort to offer teacher education students a course on technology. McKenzie's article as well as Higdon's paper deal with the question of what should be taught in instructional technology and media courses. McKenzie, working at West Georgia College, took the unusual step of surveying school administrators and teachers, teacher educators, and preservice students. She then used the survey data to develop a plan for modifying the media courses preservice teachers were required to take. Higdon, on the other hand, starts with theoretical perspectives and develops general guidelines for considering the concept of computer literacy for teachers.

Cashman and McCraw's paper on preparing preservice teachers to use technology is also a consideration of what, and how, we should be teaching the next generation of educators. Their approach to revising the media course emphasizes the need to move away from specific technical skills such as laminating pictures and making transparencies. As they say, "Recent advances in technology have made these activities passe." They do not, however, take what at first appears to be a logical step and simply replace instruction on making 35mm slides, or threading 16mm projectors, with equivalent skills on the computer (e.g., creating electronic photographs or operating the barcode wand of a laserdisk player). Instead they focus on need to provide students with a conceptual and theoretical framework for thinking about instruction, and about using technology to support instruction. Cashman and McCraw do not ignore the technical skills needed to effectively use modern instructional technology, but they do not view those skills are the central focus of their course.

The final paper in this section is Nancy Todd's discussion of creating multimedia materials for an undergraduate instructional design course at Eastern Washington University. She was one of several faculty at Eastern Washington who participated in a federally funded project to improve undergraduate education. All the faculty were interested in learning to develop multimedia instructional packages for the undergraduate courses they taught. Using *Authorware* as the development environment, Todd created a tutorial program for her instructional design course. Faculty from other disciplines created everything from a *HyperCard* stack on punctuation errors to a geology catalog of scanned images of minerals. The project, which involved faculty from many different departments, is one example of an approach to encouraging more university faculty to use technology_provide training and support to a group of volunteers who are genuinely interested in creating materials they will use in their own courses.

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What Content Should Be Included In Pre-Service Instructional Technology Courses?

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With the ever-accelerating changes in technology in the schools, the increased demands being placed on teachers to be computer and technology literate, and the growing emphasis being placed on student problem solving skills through the utilization of technology, teacher training institutions must be prepared to produce practitioners who can successfully handle these challenges (Munday, Windham & Stamper, 1991; Ritchie & Wiburg, 1993; Sheingold, 1991; Yopp, 1993). To ensure the instructional technology course delivered at West Georgia College, MED 4/601, was effective in meeting the current technology training needs of the students, the Dean of the School of Education gave the Media Education Department the charge of examining its course content and instructional activities. This paper will describe the needs assessments instruments that were designed and administered, summarize their findings, and describe the restructuring efforts that have taken place in the pre-service instructional technology course the past two years.

Needs Assessment Instruments

Three needs assessments were conducted to collect data from practitioners, teacher trainers, and students enrolled in the instructional technology classes. Information on the types of technology training needed by today's practitioners and future teachers and the effectiveness of the instructional technology course were collected.

Practitioners Technology Needs Assessment

In May of 1992 administrators and teachers in eight schools in a Georgia county school system were asked to complete a technology questionnaire. Using a 5-point Likert scale, respondents were asked to indicate their previous experience with 26 types of technology, ranging from the older to the new and emerging types of technologies being integrated in the schools. A 5 on the scale indicated the teacher was very experienced with the technology while a 1 represented no experience at all.

Teacher Trainers Technology Needs Assessment

In October of 1992 ten faculty members in the School of Education were given a technology questionnaire asking them to identify the types of content they felt should be delivered in MED4/601 and to suggest course alterations. This information was collected to reduce the content overlap between methods classes and the instructional technology class and to provide the media faculty with specific information on the types of technology that teacher trainers felt were necessary for their students. To obtain the data faculty were asked to respond to both closed and open-ended questions. They were asked to use a 5-point Likert scale and indicate how strongly they agreed with including a variety of technology content in the class. A 5 indicated strong agreement with the content while a 1 represented strong disagreement Faculty were also asked to describe any course additions or deletions they viewed as necessary to improve student's technology skills and knowledge base.

Students Technology Needs Assessment

The final needs assessment questionnaire was given to 42 students enrolled in two instructional technology classes the summer of 1993. During the last week of class students were asked to evaluate the degree of importance of the course content that was just delivered, to describe the aspects of the course they felt were most valuable, and to suggest course additions and deletions. To rate the degree the of importance of the course content a 4-point Likert scale was applied. A 4 indicated the student viewed the content as very important to their professional development in technology while a 1 represented unimportant. Students were also asked to evaluate whether or not the class had met their instructional technology training needs.

Technology Findings

This section talks about three types of perceptions: The Practitioner's, The Teacher Trainer's and The Student's Perceptions.

Practitioner Perceptions

Two hundred and forty-seven practitioners, consisting of administrators and teachers in eight county schools and their instructional support staff, completed the technology training needs assessment surveys, a 73.1% return rate. The top five technology areas identified by practitioners as needs the most training are displayed in Table 1.

The school system used in the study was in a rural setting and in the process of planning and updating the technology in their system. Those participating in the study consisted predominantly of teachers (88.5%), were females (82.6%), worked at the elementary school level(38.2%), were 30-39 years old(34%), and had 1-5 years teaching experience (29.1%).

Teacher Trainer Perceptions

Seven of the ten School of Education faculty members completed the technology course content survey, a 70% return rate. The five types of content sited as the most important for the instructional technology class are summarized in Table 2. As can readily be observed the new and emerging types of technology headed the list.

The open ended questions yielded a number of useful suggestions for course additions, deletions, and changes. Six of seven respondents reported that providing more classroom instruction on computer utilization skills and applications were needed (85.7%) while five respondent suggested more of an emphasis on planing and producing instructional videotapes (71.4%). Concerning recommended course changes, the most frequently reported suggestions were to reduce the amount of time spent on the design and development of inexpensive classroom materials (42.8%) and reducing the amount of time devoted to the operation and use of some of the older types of technology (28.6%). The opaque, filmstrip, and Ektagraphic projectors were viewed as being infrequently used in the schools today and should not be addressed in class, unless specifically requested by interested students.

Student Perceptions

The return rate on the student needs assessment was 100%. Their perceptions on the degree of importance of the course content areas are summarized in Table 3 in rank order of importance. It was interesting to discover that all of the current course content was viewed as important. The mean scores for the fifteen content areas ranged from 3.74 to 2.79 on a 4 point Likert scale.

With regard to students' assessment of the most valuable course aspects, five distinct areas emerged. Of the 22 students that responded to this question, 52.4% of the class, those aspects that had seven or more responses are listed in Table 4.

The majority of the students, 57.1%, reported that the course was appropriate in meeting their technology needs and that nothing should be deleted. Twelve students, however, listed a few course alterations. Those suggestions that had a frequency of 2 or more were: (1) reduce the

Table 1
Technology Training Needs for Practitioners

Rank	Technology	Mean	s.d.
1	Satellite Communication and Long Distance Learning	1.4	.80
2	CD-ROM Player	1.6	1.03
3	Laserdisc Player	1.8	1.27
4	Multimedia	2.1	1.26
5	Microfilm Reader	2.1	1.14

Table 2
Suggested Instructional Technology Course Content

Rank	Technology Content	Mean
1	Computers	4.8
2	CD-ROM Players	4.7
3	Videotape Player/Recorder	4.6
4	Laserdisc Player	4.4
5	Multimedia	4.2

Table 3
Degree of Importance of Course Content in MED 4/601

Rank	Course Content	Mean	s.d.
1	CD-ROM	3.74	.54
2	Computer	3.70	.71
3	Multimedia	3.68	.52
4	Videotape Production	3.62	.62
5	Laserdiscs	3.62	.58
6	Technology Safety Considerations	3.61	.59
7	Graphic Production Technique	3.43	.89
8	Long Distance Learning	3.41	.74
9	Overhead Transparency Production	3.30	.92
10	Evaluating Instructional Materials	3.30	.92
11	Communication Theory & Visual Literacy	3.20	.74
12	Photography	3.00	.76
13	Audiotapes	3.00	.91
14	Lettering Techniques	2.95	1.01
15	Mounting Media	2.79	.99

instruction on making inexpensive instructional materials such as easels, displays, and mounting materials (9.5%); (2) reduce the time spent on computer utilization skills (7.1%); (3) eliminate the instruction on the older types of instructional technology (4.8%); and (4) reduce the amount of instruction on preparing effective overhead transparencies (4.8%).

Fifty-five percent of the class provided suggestions for course additions. Those responses that had a frequency of two or more were: (1) provide more hands-on experiences with the equipment during class time (16.7%), (2) increase the amount of time spent on computer utilization skills (7.1%), (3) increase the amount of time spend on photography (4.8%), and (4) purchase more computer software for use in the computer lab experiences (4.8%).

There were a wide range of comments on the amount of instruction and lab time devoted to the computer. Some student expressed a need for more time spent on this technology and its various applications while others suggested decreasing the amount of time on computers. It was suspected that students' previous experience with the computer, their major and whether or not they viewed computed utilization skills as an essential in their field, and their overall attitude towards the new and emerging technologies in instruction strongly influenced their views of the computer and its importance in today's school systems.

The majority of the students in the instructional technology class, 88.1%, reported that the class had prepared them for their present and future technology responsibilities on the job. The student participating in the study consisted predominantly of undergraduate students (64.3%), were 18-22 years in age (40.9%), female (81%), and majored in Early Childhood Education (58.5%).

Class Restructuring

Based on the survey findings, a review of the technology literature, and speaking with other technology experts in the field, the Media Department has made a series of revisions in the instructional technology course content and activities the past year. Some of the major changes have involved the following alterations.

1. More instructional time is provided on the use and operation of the new and emerging types of technologies in the schools. Students have increased amount of hands-on learning experiences with a computer of their choice (Apple, Macintosh, or IBM). They are required to use a word-processing program to critique selected software and encouraged to use a computer graphic program for the production of transparencies. They are also given hands-on learning experiences to experiment and become familiarized with video camcorders and

Table 4
The Most Valuable Course Content in the Instructional Technology Class

Rank	Course Aspect	N	%
1	Information on the new and emerging technologies in the schools (computers, video, laserdiscs)	22	52.4
2	Learning how to operate a variety of technology through demonstrations and hands-on learning opportunities	10	24.0
3	Information on how to design and prepare inexpensive instructional materials (overhead transparencies, mounting materials)	7	16

tripods, CD-ROM players, laserdisc players, an electronic copystand for photography, and a variety of software for the newer types of technology. Students who are unfamiliar with operating some of the older types of technology are given individual instruction by the instructor or they elect to use technology tutorials that list the operating procedures step by step.

2. More class time is devoted to student assessment and experimentation with a variety of software used on the newer types of machines. Students are required to conduct a literature search using ERIC on CD-ROM; to preview and critique a selected CD-ROM program (Compton's Multimedia Encyclopedia, Mammals, Science Helper, Children's Reference plus); to preview, critique, and map a selected videodisc program; and to preview and critique a selected computer program that is applicable to their field of interest.
3. Less time to spend on design and production of inexpensive instructional materials. The use of the dry mount press to laminate and mount instructional materials has been eliminated from the course except in cases where students request instruction in this technology. Since the majority of the students have received previous instruction on the design and production of educational displays, this area is briefly reviewed. The student requirement of designing and setting up a display has been eliminated. The design and production of instructional overheads is still addressed. However, a greater emphasis is placed on computer generated transparencies where word-processing or graphic programs are used.
4. A greater emphasis is being placed on students' problem solving and critical thinking skills in technology. Instructors spend a great period of time modeling the appropriate use of technology, familiarizing students with a wealth of hardware and software, and discussing innovative ways in which technology can be effectively integrated into the curriculum.

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Profession-Specific Computer Literacy: Microteaching in an Educational Computing Course

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"How do you eat an orange?" The teacher education students seated at the computers turn and look quizzically at the teacher. One student answers, "I peel it and divide it into sections." Another, still puzzled, responds slowly, "I cut mine into quarters and eat it like a piece of watermelon." The teacher education student conducting the microlesson, replies, "Well, I normally bite a hole in the top and suck out all the juice." She continues, "Today, we are going to use a computer program called, *The Factory*, to explore different approaches to solving problems. As you use the program, think about the methods you used to achieve solutions and we will share our techniques at the end of the class period."

Why would a preservice educator in an educational computing course start a lesson with a series of questions and answers about oranges? With the seemingly incongruous example of the orange, the teacher education student is able to focus the attention of the *students* on the many ways of solving a problem. One of her objectives is to help them understand that there may be many "correct" ways of solving a problem. This set induction establishes the beginning of a microlesson in a required undergraduate educational computing class. The *students* in the simulated class are actually other teacher education students who take the role of K-12 children as their classmate takes on the role of teacher. This activity, which was recently added to the University of Houston course, is at the heart of an effort to shift the focus from generic computer literacy skills to profession-specific computer literacy.

Microteaching

The microteaching model, developed at Stanford University in 1963, " was designed to provide teachers with a safe setting for the acquisition of the techniques and skills of their profession" (Allen and Ryan, 1969, p. 4). The purpose of this model is to allow preservice or inservice educators to practice teaching strategies in a clinical environment where they can actually teach a lesson and receive immediate feedback from their peers and their instructor. Allen and Ryan (1969) suggest that microteaching is an "idea" built on five fundamental propositions:

1. *Real teaching:* Bona fide teaching does take place even though the activity is simulated rather than real.
2. *Lessening complexities:* Class size, scope of content, and time are all reduced.
3. *Focus:* Training for the accomplishment of a specific task.
4. *Control of practice:* Time, students, method of feedback and supervision, and many other factors can be adjusted.
5. *Feedback dimension:* Normal knowledge-of-results is increased through a critique of performance immediately at the end of the lesson.

During the microteaching experience, the person taking the role of teacher is required to incorporate specific teaching strategies into a short, ten to twenty minute lesson in which many aspects of a normal teaching experience such as scope, time period, and number of students are limited. By teaching the microlesson, the learner is experiencing these specific strategies and internalizing them (Davis, Maher & Noddings, 1990) through the actual practice of the skills involved. When not teaching, the teacher education students are observing a microlesson or are role-playing K-12 students of a given age and ability level (Gregory, 1972). In either case, the student participants/observers provide written and spoken evaluations of the encounter. The facilitator supervising the microteaching experience provides feedback and suggestions, and helps the student think through the strengths and weaknesses of the microlesson.

Microteaching adapts itself to a wide variety of teaching situations. Many different teaching strategies can be practiced, examined, and evaluated in a situation that is like a real classroom but without the risks and potential problems that can occur when an inexperienced teacher education student attempts to teach a class. This low-risk environment eliminates the *fight-for-survival* syndrome experienced by many preservice teachers during their field experience, and by first-year teachers during their induction period. Microteaching also gives students an opportunity to learn about teaching as a professional activity rather than an abstract, scholastic activity. Many students can read a textbook chapter on cooperative learning, for example, and pass an objective test on the material without being able to actually set up and facilitate a successful cooperative learning activity in a classroom. Declarative knowledge does not automatically generate procedural, conditional, and problem solving skills. Microteaching, because it requires teacher education students to think, plan, and execute activities much as they would in a real classroom offers them an opportunity to begin learning professional practice skills before they enter the classroom. These points apply equally as well to objectives in an educational computing course as they do to methods courses. There is, for example, a major difference between writing an evaluation of a piece of educational software after looking at it in a computer lab and microteaching a lesson that incorporates that software package. With those points in mind the University of Houston began emphasizing microteaching in the required undergraduate and graduate educational computing courses in the summer of 1994.

Computer Literacy for Preservice Teachers

The preservice computer literacy course at the University of Houston has undergone many changes in the past five years. The most significant of these changes occurred approximately three years ago when the course format changed from a basic literacy/programming perspective (learning about the computer) to a modular approach that emphasized the use of computers and other technologies in education. This modular approach was based on the applied behavioral model of Keller 's Personal System of Instruction (PSI). Fabris et al (1993) described the PSI-based course. It divided the objectives into modules and then required students to pass tests to demonstrate mastery of each module. Some of the tests were objective, multiple choice exams, others were assignments that required hands-on work at the computer. The PSI approach was developed to meet the needs of the large number of students who take course. About 200 students per semester take the course. The students vary from first year students to graduating seniors. There are elementary education majors and secondary education majors with a variety of specialties. Some have no experience in the use of technology and a few are competent in the use of technology in business or personal settings. The common thread, however, is that all the students lack of experience with the use of technology in education. Therefore, the course is designed to be flexible in guiding preservice educators as they explore specific aspects of information technology.

The personnel available to support this course each semester includes a faculty advisor, a doctoral student who receives one course credit for supervising all the sections, and graduate teaching assistants who receive a credit for teaching one course for each set of two 20-student section they teach. Each section meets once a week for two hours in one of the college's computer labs. To cope with the students' feelings of inadequacy in the various aspects of technology, the graduate student instructors act as facilitators, supporters, coaches, and guides as well as technical consultants.

A traditional PSI system usually emphasizes declarative knowledge, primarily because that is the easiest form of knowledge to test when you are dealing with large numbers of students. Declarative knowledge is not, however, sufficient to prepare students to practice professionally. Willis (1992) suggests an adequate course in technology for teacher education should cover profession-specific computer literacy. This type of course deals with the "concepts, theories, and procedures that relate specifically to the *instructional* uses of information technology" (p. 108). Learning to use the computer and related technologies in and of themselves is not sufficient. It is also not sufficient to teach students only declarative knowledge about the instructional uses of technology. The preservice educator must have the opportunity to practice and experience the integration of technology into actual lessons. At the University of Houston we have attempted to provide that opportunity through microteaching.

The microteaching module (Jaehne and Turner, 1993), used by the University of Houston program, was designed to accommodate the personalized quality of the modular model. The primary purpose of this module is to allow the teacher education student to explore instructional strategies that incorporate various forms of information technology. The microteaching module requires students to teach, observe, and play the role of student in four different microlesson formats. These formats have two requirements. One relates to the type of technology used (e.g., drill and practice software versus hypermedia programs); the other relates to the instructional strategy used (e.g., teacher centered versus student centered):

1. *Microteaching 1–Tool Software* involves choosing and

implementing a lesson that includes the use of a word processing, database, or spreadsheet application package. This lesson can be either teacher centered or student centered.

2. *Microteaching 2–CAI* incorporates Computer-Assisted Instruction (CAI) software evaluated in a previous module. This lesson is teacher centered with the computer taking the role of teacher. The human teacher acts as a facilitator, troubleshooter, and guide.
3. *Microteaching 3–Multimedia* demonstrates the use of CD-ROM or videodisc materials in a lesson. In contrast to the two previous lessons, this media challenges the teacher to design a lesson that requires active participation of the pupils using only one CD-ROM or videodisc player. In addition, pupils using the hypermedia aspect of electronic encyclopedias like *Encarta* present the teacher with many aspects of lesson design and implementation not yet encountered. The multimedia lesson must use a student centered strategy such as cooperative learning.
4. *Microteaching 4–Hypermedia/Telecommunications* illustrates the interactive environments of Hypercard or telecommunications integrated into a lesson. The presentation and interactive authoring capabilities of Hypercard and the virtually untapped resources of telecommunication present a fertile area for new and creative lessons. This lesson can either be teacher or student centered.

The preservice educator (teacher) is required to execute three of the four microlessons. Each microlesson consists of preparing a written lesson plan and any accompanying materials, choosing the software and data (if required), "setting-up" all the necessary equipment, and teaching a 10-minute lesson. Each student is also required to participate/observe in 10 microlessons done by their fellow-students.

Implementation of Microteaching

During a typical microlesson, the teacher outlines the setting in which the lesson will be taught, establishes a focus for the "class", teaches the lesson, and closes the lesson appropriately. At the conclusion of the microlesson, a short discussion ensues on the instructional strategy used and the integration of the particular technology used. During the discussion period, the participant/observers prepare written evaluations on how well the technology has been integrated into the lesson. These evaluations are collected and given to the preservice educator for immediate feedback.

Although the process of incorporating microteaching into the educational computing course was relatively straightforward, the actual implementation called for considerable finesse on the part of instructors. For many of the students, this was the first education course they had taken. They were unfamiliar with basic lesson plan concepts instructional strategies such as cooperative learning. In the initial microlessons, many students used the computer only as a **reward** or **electronic recess** for their pupils. For example, Frank started his microlesson with a poster containing the mnemonic, Please Excuse My Dear Aunt Sally. He lectured on the order of operations used in mathematics (Parenthesis, Exponents, Multiplication, Division, Addition, and Subtraction), reminding the pupils how helpful the mnemonic would be. He gave each pupil a work sheet with sample problems to complete, and then, allowed the pupils to "play" *How the West Was One*, problem solving software that teaches order of operations. The discussion following the microlesson suggested that Frank had put much time and thought into the preparation of the microlesson but the pupils were passive most of the time. It was suggested that Frank might have started with the software, allowing the pupils to "discover" the order of operation and then reinforced this discovery through discussion and an explanation of the mnemonic. At the end of this experience, the pupils could use the problem solving software a second time and chart their improvement.

Susan, on the other hand, focused her students with a recording of the *Star Wars* theme but "told" the class the advantages and disadvantages of *Math Blaster Plus* software instead of teaching her simulated class. This microlesson became a traditional talk about-and demonstrate inservice program. In the discussion that ensued, it was suggested that Susan use a variation of the approach suggested for Frank. However, when Susan's pupils finished the initial "shooting the alien fraction", each pupil would work through the fraction tutorial in *Math Blaster Plus* and then attempt to "shoot fractions" again, measuring the increase (or decrease) in new problems solved.

Even though these discussions were guided by the graduate student instructors, the *teacher, pupils* and *observers* were active participants. As the discussions about how lessons could have been taught or how things could have been handled differently progressed, the *teachers* became more comfortable using the technology in teaching situations and "true" integration began to take place. For example, Shane taught a lesson to a ninth-grade English class reading *Of Mice and Men*. He started the lesson by reading a few sentence indicative of the slang found in the book. He asked the pupils seated at the three Macintosh computers to look at a file prepared from the text and loaded into Microsoft Works. The class worked through the first sentence together converting Steinbeck's slang into current English. Shane then told the class to work through the remaining passage in the same manner while he worked with individual students who were having problems. To conclude the lesson, his class discussed how converting slang to standard English usage helps you understand the story. He asked the students to print their results so they would have examples to use as they continued reading, and he posted the telephone number of the "Slang HotLine" that had been established for those who might have problems interpreting various passages. The participant/observers rated Shane's microlesson highly. The discussion that followed centered on the pupils being responsible for their own learning.

Impressions, Issues and Future Plans

Allen and Ryan (1969) suggest that "preparing beginners for their initial teaching experience — whether student teaching or internship — has been one of the major soft spots in professional education" (p. 60). Microteaching is one way of bridging that gap that has articles and textbooks (as well as computer lab exercises) on one side and classroom teaching on the other. Many students commented that microteaching alleviated the uncomfortable feeling people new to computers have when trying to implement them in a classroom environment.

Students evaluated microteaching as an extremely positive experience. As one student commented, this was "an exciting and stimulating approach to what I feared would be a difficult activity." Another stated, "I feel much more comfortable using computers in a teaching situation now that I have some experience."

In a general discussion, students felt that having experienced using technology in a teaching situation made their observations of real teachers using technology more meaningful. Microteaching does seem to provide a safe atmosphere in which preservice educators can practice and receive effective and immediate feedback.

Microteaching is not, however, easy to implement. It demands a great deal of time, as Gregory (1972) noted. In the University of Houston course, course instructors are confronted by conflicting demands since their time must be totally devoted to the microlesson when one is being delivered. If you assume each microlesson will take 20 minutes (an optimistic assumption), and a total of 20 students in each section, then 20 hours of the 45 contact hours would be devoted to microteaching. This can be reduced somewhat by allowing students to work together on lessons but the time demands are still high. Students in the UH course must also demonstrate they have mastered the basics of an integrated software package by completing a number of education-related assignments, complete a set of modules on everything from operating a laserdisc player to reviewing software in their subject area, and pass tests over chapters in the educational computing textbook. Adding microteaching does not allow the instructor much time to work with students in other areas. If the other aspects of the course were not modularized it would probably be impossible to add microteaching to the course.

Another problem is resources. Although the University of Houston has two networked IBM labs, two networked Macintosh labs and a growing collection of multimedia resources including CD-ROM drives, videodisc players, and scanners, students often have problems with access. Microteaching intensifies the problem. The same is true for software. Despite constant updating of the software collection using funds collected from students, we need more software in virtually every content area and level.

In spite of problems involving class time, hardware needs, and software needs microteaching is a valuable addition to the educational computing course. In fact, if the goal is to provide students with experience integrating technology into the curriculum, microteaching is one of the most efficient ways to do that. It does not replace observation in schools or student teaching activities, but it may make those activites more meaningful and more effective.

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A Technology Course for Secondary Preservice Teachers

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The job of integrating technology into K-12 schools involves many components and requires the cooperation of seemingly diverse groups ranging from classroom teachers to administrators, parents, community members, businesses, state and local government agencies, and units concerned with the education of preservice and inservice teachers. Within these diverse groups the teacher educator plays an important role, especially to the preservice teacher, for whom the first connection between technology and the education process may be made during preservice education. The teacher educators who provide quality, technology-rich experiences can significantly influence the preservice teacher's technology-related skills and attitudes.

Within the sequence of courses available to preservice teachers, a model has emerged which offers a course on technology and education. Ideally, the model extends technology integration into formal methods courses, as well as clinical and field experiences, in order to build a comprehensive, in-depth experience for preservice students. Characteristically, however, the use of technology in methods courses and preservice experiences is more often than not dependent on a random chance of being paired with technology-experienced teachers or teacher educators. Therefore, the quality of the resulting experiences can vary greatly. This makes the technology and education course a critical key for the preservice teacher.

Frequently, the technology and education course may be aimed toward education students in general, or, due to program constraints, toward preservice teachers preparing to teach grades K-8. The very different needs of students who are preparing to teach at the secondary level are often not addressed. This paper examines the development of a technology and education course to meet the specific needs of secondary education preservice teachers.

The Setting

The College of Education and Allied Professions (EDAP) at Bowling Green State University (BGSU) is one of the largest in the nation with 3,850 undergraduates, 525 graduate students, and 137 full-time faculty. There are 7 academic units in the college. In 1990 the college was one of 11 institutions selected to receive the American Association of State Colleges and University's Christa McAuliffe Award for innovation and outstanding collaborative programs with area school districts. Within the College, the Department of Educational Curriculum and Instruction has, historically, been responsible for providing methods courses to elementary and secondary teacher education majors and relevant technology education to elementary education majors. Indeed, in a recent revision of the department's mission statement, faculty chose to recognize the importance of technology by formally stating that part of their charge was to educate students to appropriately use technology in the classroom.

Since 1984, all elementary education preservice teachers have been required to take a 3 semester hour course on computer utilization in the classroom. This course has evolved over time to include various other technologies.

The course makes use of a computer classroom to provide both hands-on experiences and demonstrations during class meeting times. Work outside class is supported by the Clinical and Computer Lab facility, which houses two separate computer labs and a collection of about 700 software titles, as well as videodisk, VCR, CD-ROM and audio hardware. Both the computer classroom and the Clinical and Computer Lab facility provide access to the campus computer backbone. Students have access to e-mail and the Internet and to the continually evolving OhioLink resources that provide access to on-line research materials. Beginning in the fall of 1994, a new classroom building will provide technology-enhanced classrooms as well as three special rooms specifically equipped with a full range of facilities for distance learning activities. Approximately 300 students per year take the course.

The Current Course

Educational Curriculum and Instruction (EDCI) 365 - Computer Utilization in The Classroom - has, historically, been taught in a lecture/lab format. Students meet in a large group (about 80) for a 90 minute lecture/discussion/demonstration/activity session once a week. They also meet during the week in a smaller group (about 28) for 90 minutes in a lab setting geared toward hands-on activities. This format will change as of the spring '94 semester when students will meet for a total of 3 hours per week in the computer classroom.

The course is taught as an educational rather than a training experience and is based on a model of the teacher as a reflective practitioner. In this model, teachers are viewed as professionals who are prepared, through education and experience, to make meaningful decisions about students' needs and the process of education. Preservice teachers taking the course are expected to analyze and evaluate their potential role in making judgments about how to help students learn, about the teaching profession and their role in it, and about the political and community contexts in which schools exist - all in relation to integrating technology into the schools.

Within this framework, EDCI 365 is taught as a survey course on technology in education, similar to survey courses taught on a liberal arts model. In the course, students are: (a) expected to gain specific hands-on skills with regard to technology; (b) required to work individually and collaboratively on relevant projects; (c) expected to read a considerable amount of material from various sources about current issues, research, theory, and practical activities. Through such experiences, students are expected to gain a broad understanding of technology in education as a basis for making informed decisions about the use of technology in the schools. Topics covered in the course include: word processing, telecommunications, multimedia, software evaluation, technology integration, Logo, computer managed instruction, materials preparation, databases, spreadsheets, hypermedia, resources for technology in education, ethics and equity issues, research, and future trends.

Elementary education students have been the target audience for the course. As a result, course experiences and activities are geared towards that group, having as their focus, the use of technology with primarily preadolescent students in a self-contained classroom setting. In such a setting, the teacher is expected to have broad knowledge across a wide range of subject areas. Subsequent to the course, these students will take a block of methods courses that will provide specific information and experiences, by discipline, on what is taught to (learned by) elementary school students and how to teach it. Ideally, this coursework will build upon the skills and concepts related to technology and teaching developed in EDCI 365.

Need for a Secondary-Specific Course

Historically, from a national perspective, preparation for secondary teachers has, primarily, been viewed as content area preparation, with much less attention being paid to methods of instruction and other relevant educational issues. In the worst case, secondary students might receive one methods course or, sometimes, one general methods course followed by a subject-specific course and then student teaching. While some programs, including the program at BGSU, offer secondary preservice teachers greater depth regarding educational issues and skills, secondary majors have generally been viewed as subject matter specialists first and teacher preparation candidates second. This is to some degree understandable, since, in their subsequent teaching, these students will be expected to have in-depth knowledge of their chosen area. Knowledge that is every bit as rigorous as any undergraduate's who has majored in the given discipline but has no intention of teaching. Understandable though it may be, this situation is proving to be undesirable when preparing students for the job of teaching in a secondary school. For, even when more in-depth experiences with educational issues are provided, secondary majors rarely encounter technology education that is specific to the setting in which they will eventually teach - a setting that differs greatly from that of an elementary school. As an example, the secondary setting will involve a population that is dramatically different from those with whom elementary preservice teachers will work. These differences include, but are not limited to, intellectual, emotional, and maturational development. Given the factors cited above, it was proposed that a version of EDCI 365 geared specifically toward secondary preservice students be created.

The course proposal met with support from the secondary faculty within the department. Faculty were concerned that secondary students were graduating without any formal education regarding the possibilities of technology in secondary schools and without any relevant skills. It was pointed out that, across the country, integration of technology into the schools has been more limited in scope and occurrence in secondary education than in elementary education. Although there may be many reasons for this, including the way the secondary schools are structured (essentially on a 19th century, industrial economy model), faculty expressed the belief that part of the problem was a lack of technology instruction specifically geared toward the needs of secondary preservice (and inservice) teachers.

An area of concern was raised, however, that relates to the general proliferation of course requirements for undergraduate students. During the 1980's, as the process of curriculum development and requirements at the university and college levels became more politically based, legislatures, other government bodies, and professional organizations began to have more of a say in student requirements. Currently, few students, if any, can complete a "four year" program in under five years. With this in mind, it was agreed that a pilot version of EDCI 365 - Secondary, would be developed and taught during the spring of 1994. Approximately 15 - 20% of the course content would include relevant self-instructional modules from a currently required 2 semester hour course, Library and Educational Materials (LEM) 301-Basic Educational Media. Pending successful implementation of the EDCI 365 Secondary pilot, the plan is for LEM 301, which does not have a computer and associated technologies component, to be dropped as a requirement and EDCI 365 Secondary to be added. This plan currently has strong support from secondary faculty, including the LEM 301 instructor.

The Secondary Course

Although there will be some similarities between the elementary and secondary versions of EDCI 365, there will be important differences. The similarities include an emphasis on teaching a survey course based on the reflective teaching model, while remaining a course where specific skills related to technology are developed. The overall scope of both courses will be similar in relation to their survey aspect where most of the topic coverage, at *the category level*, will be the same. However, the topic *content* will be different. Both courses will be heavily hands-on oriented, with outside readings geared to the introduction and exploration of relevant concepts. The readings will, however, be different, with the secondary course offering practical examples, research, and theory related to secondary schools. Students will conduct in-depth readings in their area of chosen subject matter specialty and technology. Both courses will require individual and group work. Instructors of both courses will model a variety of effective teaching practices and use that modeling as a course topic to further enhance students' understanding of effective practice.

Several major differences between the two courses are due to the placement of the secondary teacher in the role of creator of materials. Given that secondary teachers are expected to have in-depth subject knowledge, students will spend more time, mastering tools such as hypermedia, investigating specific methods of integrating hypermedia into the curriculum, and, creating and presenting hypermedia products for use in the classroom. Students will access and use on-line resources for classroom instructional purposes to a greater depth and degree than their elementary counterparts. Such uses will initially be subject-specific, relating to the preservice students' areas of specialty. One theme to be developed in the course is the integrating of technology into the thematic, cross-disciplinary, development of instructional units. This is a valuable activity that teachers in secondary schools need to pursue but rarely have the time or experience to successfully complete. (Although somewhat true for elementary teachers, it is much more difficult to achieve at the secondary level, due to a lack of relevant education during preservice secondary preparation and to the structure of secondary versus elementary schools.) One last obvious difference in course material will be the context in which technology is viewed in relation to secondary student populations. Issues related to using technology when teaching adolescent students how to problem-solve, write, read, etc., will yield different material than that covered in the elementary version of the course.

Presently, hardware and software support for the course consists of a Mac-based environment with CD-ROM drives, as well as interactive videodisk workstations. Access to e-mail and Internet services, in addition to relevant research resources provided by the OhioLink project, are available. In the fall of 1994, distance learning facilities will become available on campus and will be integrated into both the elementary and secondary versions of the course.

A Curriculum and Instruction Perspective

The perspective from which technology is viewed is an important consideration in the development of this course. Both the secondary and elementary versions of the course are offered through the Department of Educational Curriculum and Instruction. As a natural consequence of this, the course pays particular attention to the effect technology might have on curriculum development and on the methods of instruction employed by the teacher. Attention is also paid to the role of the teacher as a change agent, both historically and currently during this time of school restructuring (or, at least to date, much talk about school restructuring). Such an orientation can help students reflect on the positive and negative aspects of introducing technology into the schools. It can also help students perceive technology as a force within society that affects not only the schools but other institutions. Such reflection can positively benefit informed decision-making by beginning and continuing teachers about the direction in which education should proceed. Ideally, the preservice student will gain a view of the broader realm in which schools and teachers function, and will, once in the classroom, make valid, informed, professional decisions about technology - decisions that will benefit students.

Conclusion

Many people have been working for a long time to successfully integrate technology into education at all levels, but there is still a long road to travel to arrive at the reality promised by the vision. Elementary and secondary teachers work in very different settings with very different populations. Meeting the specific technology needs of elementary and secondary preservice teachers is one way to help make

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the vision a reality. This project is an attempt to make that happen.

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Alternative Approaches to Defining Computer Literacy

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Current and past quantitative and qualitative research regarding literacy and computer literacy has produced conflicting and inconclusive arguments as to what literacy is (Scribner, 1984; de Castell and Luke, 1983; Erickson, 1984; Gee, 1987). The discrepancies among study results lie in the interpretation of answers to the following questions:

- what is literacy,
- what is functional literacy,
- what skills are necessary for literacy,
- to what level of ability does the literate person function,
- what are the social, economic, cultural and empowerment factors involved with the defining of literacy and
- what part does self efficacy play in becoming literate?

The primary assumption of this paper is that the definition of computer literacy should be derived from a general definition of literacy. Computer literacy should be achieved with skills that are determined by the preservice teacher in a computer literacy course.

What is literacy?

Goody and Watt (1968), give a historical and theoretical explanation of literacy that encompasses the anthropological and sociological origins of literacy. de Castell and Luke (1983) developed an American public school definition that explains the culturalization and politicalization of literacy. Scribner (1984), examines the definition of literacy as a metaphor that impinges upon the proficiency, social power, and ego of the literate individual. Webster's (1983) is the most succinct, "the condition of being educated." To become literate is to become educated or "instructed; furnished with knowledge and principles; trained." Literacy is the acquisition of education, any education. To the preservice teacher in computer literacy, literacy is the acquisition of knowledge, principles and training in computer usage. What the knowledge, principles and training constitutes leads to the development of functional literacy.

What is functional literacy?

If literacy is the acquisition of education, then functional literacy is the acquisition of an education that one may use in a practical or working relationship. Scribner (1984) refers to functional literacy as "the level of proficiency necessary for effective performance in a range of settings and customary activities." Functional literacy then could be defined as instruction for use in everyday occurrences or activities in which one engages. Functional literacy would endow the learner with the ability to work and interact on a daily basis within the learner's environment. This functional literacy would give the learner the skills needed to carry out any activities for survival within the learner's work, play, and living conditions. In the case of the preservice teacher and computer literacy, functional literacy would be the necessary skills to operate a computer. The delineation of necessary skills then must be addressed.

What skills are necessary to literacy?

A review of the research to determine what is computer literacy, shows a variety of definitions or delineations of skills which have been issued by various committees or government agencies (Adams,1985; Hannum, 1992; Fourgere, 1990; Blake,and Tjoumas, 1990). These definitions and delineations varied greatly, depending on the computer literacy course, program, or focus of instruction. If the focus is science-oriented, then the computer literacy skills become more specialized in nature. Word processing, spreadsheets, and database creation and usage are the primary skills listed as being taught for basic skills. The identification of basic skills become even more qualified by the level or degree of proficiency within the application programs.

Proficiency level of literacy

Proficiency levels of literacy are ephemeral in nature. Who decides the level of proficiency? Colleges of education, state agencies for teacher certification, and national education directives are the primary establishers of proficiency criteria for preservice teachers. The criteria are general and allow the various schools of education a wide interpretation in relation to the specific school's program. Therefore, each school develops their own criteria of proficiency level in computer literacy for preservice teachers. This individualization of criteria varies across the schools for teacher training (Tuman,1992). The imposed computer literacy proficiency levels are achieved by preservice teachers for credit but are not necessarily functionally learned (Higdon,1993). Generally, the preservice teacher learns computer literacy in a one semester course to meet the imposed criteria without regard to future use in their chosen careers. The preservice teacher needs to be impressed with the social, economic, cultural and empowerment factors that come with computer literacy.

Social, economic, cultural and empowerment factors of literacy

Literacy, whether language, computers, mathematics or science, contains elements of prestige for the learner. These elements can be social, economic, cultural or provide empowerment for the learner. Literacy can increase the social standing of the learner by giving the learner the ability to interact within the social structure of the learner's environment. The condition of being literate can also improve the economic standing of the learner by giving the learner new skills useful within the workplace that place a greater economic value on the learner. Computer literacy is just such an economic value booster for preservice teachers. Literacy has been, historically, a means of class division. Those with the ability to communicate and function on a literate level possessed a class distinction which set them apart from the illiterate. The development of computer literacy empowers the learners to not only break the barrier of class divisions, but also to nourish and build a pride of achievement which builds self-confidence.

Self efficacy and literacy

Bandura (1977) states in *Social Learning Theory*, that perceived self-efficacy is important to the attainment of new learning experiences. If the learner believes that a new skill or knowledge is within the learner's capabilities, then the new skill is achievable. If that feeling of possible mastery is missing then the learner typically will not even try to learn (Shrunk, 1989). If this concept is applied to the preservice teacher in a computer literacy context, then the answer to increased computer literacy among preservice teachers is to develop a perceived self-efficacy concerning computer usage. In a pilot study (Higdon, 1993) of preservice teachers enrolled in a competency-based computer literacy course, perceived self-efficacy was a mitigating factor in the learning of not only computer basics, but of the continued honing of proficiency within the various computer applications. Interviews with the preservice teachers indicated that even those students who entered with a fear and/or hatred of the computer learned the basics and then proceeded to increase their proficiency levels with an enthusiasm that was previously lacking. Those students who had some computer knowledge and skills prior to the competency-based class increased their knowledge base in areas in which they were lacking (telecommunications, graphics, and multi-media). The more proficient preservice students also expressed in interviews an increased self-confidence in their abilities to perform beyond their previous expectations. Therefore, perceived self-efficacy leads to a self-determination of what literacy is for that specific learner.

Conclusion

The concept of computer literacy should be based on a broad definition. Literacy becomes a personal achievement which is perceived, guided, and achieved due to the learner's own belief in self abilities. The learner's achievement of literacy comes through the realization of what is important for the learner to know and want to learn. This realization may occur due to social, economic, cultural or empowerment factors. The need to function within a new social or economic atmosphere (work), increase earning potential, or secure a personal sense of self-worth, becomes a strong factor for literacy achievement. Literacy and the extent of literacy proficiency are then the result of a personal decision and achievement. Literacy cannot be imposed. Therefore, the preservice teacher in the pursuit of computer literacy will be the deciding factor as to what computer literacy is. Computer literacy will become the knowledge and skills the preservice teacher deems important enough to learn and use.

Note: Thanks to Ellen O'Brien for being a sounding board. Thanks also to Dr. Judith B. Harris for the direction and encouragement of my studies.

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Meeting the Challenge: Training Preservice Teachers to use Technology

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Teachers of tomorrow will be expected to integrate traditional and advanced media technologies into their instructional strategies. However, most preservice teachers lack instructional models in which technology is a vital component. At Emporia State University and the University of Southern Indiana, a variety of technologies are used in the instructional technology courses to deliver course content and engage students in learning. This paper presents the design rationale of both courses, instructional strategies used, and considerations for integrating technology in teacher education courses.

Defining the Challenge

The challenge for teacher education programs is to develop an instructional media program that prepares preservice teachers to plan for the use of traditional and advanced media technologies, and to develop the skills and comfort levels necessary to effectively use media in the classroom environment. It is the task of instructors of instructional media programs to design learning experiences that meet the educational needs of these emerging teachers. Those needs include: (1) a theoretical background for utilizing media; (2) familiarization and skills using traditional media which many schools are still using; (3) familiarization and skills using advanced media technologies, with the expectation that these teachers will be the technological leaders as schools become equipped with advanced technology; and (4) experience learning in a process oriented curriculum that focuses on critical thinking, problem solving and communication skills. This paper presents how the undergraduate instructional technology courses at Emporia State University (ESU) and the University of Southern Indiana (USI) have been designed to meet the challenge.

Teachers of tomorrow will be expected to integrate traditional media and advanced computer technology into their instructional strategies. Yet studies (Byrum & Cashman, 1993) reveal that most preservice teachers lack instructional models in which technology is a vital component. At ESU and USI a variety of traditional and advanced instructional technologies are used in the instructional technology courses to present content and engage students in learning. Instructional technologies at both universities are presented as: (1) resources for teaching concepts, (2) tools for teachers, and (3) as tools for the K-12 student. Students are encouraged to no longer only think of technology as a "curriculum enhancement," but as a collection of tools that will enable them and their future students to construct and demonstrate their own knowledge. What is more important, they are taught to view the use of all technology as a component of "instructional technology" that encompasses a systematic plan for teaching and learning.

Design Rationale

Previous media courses at both universities were derived from the "audio-visual" courses of past years. These courses focused on the skills needed to thread motion picture projectors, dry mount and laminate pictures, produce dittos, slide shows, and overhead transparencies. Recent advances in technology have made these activities passé. In most schools today, photocopies replace ditto sheets and laminating machines have replaced presses. In addition, the 16 MM projector has been replaced almost exclusively with the videocassette recorder, and the slide projector is fast being replaced by computer generated slide shows, still video, CD-ROM and videodisk technology.

Instructional technology courses at both universities have been designed to provide students with a theoretical framework for using instructional technology and with hands-on experience using the various advanced media technologies. The courses are based on the following theoretical underpinnings:

1. Instructional design provides a plan for the development of instruction.
2. Technology provides means of implementing and/or enhancing the instruction so that it becomes as efficient and effective as possible.
3. The effectiveness of media is dependent upon the lesson design.

Media should be selected based on the developmental levels of the students, instructional objectives, lesson content, and constraints to the instructional environment.

Instructional Strategies

The curriculum of the future will be process-oriented and emphasize critical thinking, problem solving and communication skills. This curriculum will depend heavily on the use of information technology (Henderson, 1992). In order to prepare future teachers to use a curriculum that emphasizes these skills, they must have experience learning in an environment that uses this type of curriculum. The instructional media courses at both universities create such a learning environment. They are designed to emphasize critical thinking, problem solving, communication, and self-directed learning. Course projects encourage group collaboration and provide problem-solving situations in which solutions are varied.

The organization of group collaboration differs at each university. Students at ESU work on projects individually, with partners, and in small groups. Students may choose whom they will work with on a project. Except for the instructional video and visual and audio interpretation projects, which emphasize cooperative learning, students may choose to work alone. In contrast, students at USI work on most projects in small groups. At the beginning of the semester, based on their interests, students are placed in groups of three to four members.

To ensure adequate instructional planning when using any media format, students must understand the basic components of instructional design. Courses at both universities emphasize the learner as the focus of instruction, and those learner characteristics as well as instructional objectives must guide the design process. Students at USI learn a simplified instructional design model with which they work within their own content areas. The model consists of a simulated needs assessment, identifying the characteristics of the target audience, developing and correctly writing instructional objectives, delivering instruction, providing for feedback and assessment, and evaluation and revision of instruction. Because of the time constraints of a two credit hour course, at ESU, students use the ASSURE model (Heinich, Molenda, & Russell, 1992). This media selection model incorporates portions of the simplified instructional design model used at USI. The concepts, of criterion referenced testing and mastery learning, are explained and modeled throughout the courses at both universities.

Students are required to write objectives for each project throughout the course. Because of this requirement, the first project at each university is developing and writing objectives. Four different instructional scenarios are provided, for which each student must write instructional objectives. These objectives must include the audience, behavior, condition, and degree of accuracy expected.

Writing clear, concise instructional objectives is a challenge for most students. Many have weak writing skills. They also struggle with the concept that objectives are what the learner will be able to do after instruction, rather than a description of an instructional activity. Because the development and selection of instructional media is dependent on instructional objectives, students are expected to master this concept. Therefore, students may choose to rewrite each objective until it is correct.

Students at both universities have had little exposure to technology. Most are traditional students who attended rural K-12 schools and are accustomed to traditional didactic pedagogy. In addition, few of the students are independent learners. At both universities instructors use the presentation software *Aldus Persuasion* is to present various topics throughout the semester. The presentations are stored on lab computers to allow students access to them outside class time. Lab assistants are available to provide computer assistance to students. Making lecture materials available to students on lab computers has been beneficial in three ways. First, it has been proven to be an effective mean of encouraging learners to be responsible for their own learning. Students can no longer complain that the instructor covered the material too fast, or they were absent and had not been able to get the notes from a classmate. Second, students gain practical experience using technology as a study tool. Lastly, students are being exposed to an instructional strategy that uses technology to provide for individual differences.

At USI students have hands-on experiences using *Aldus Persuasion* to develop their own presentations. They work in small groups to create overhead transparencies and computer generated slide shows. This is possible due to the availability of computers in the lab; a ratio of one computer for three students. As resources become available, this project will be implemented in the ESU curriculum. Currently ESU students create overhead transparencies by creating cut and paste masters, photocopying and using a thermafax machine. Some student use computer generated lettering and visuals in creating their transparencies. However, presently this is not a requirement due to students lack of access to computers.

Students at both universities develop instructional bulletin boards. They are expected to apply elements of visual design and create instructive bulletin boards that are relevant to the objectives that they have written. At ESU, still video of student created bulletin boards from past semesters is used to discuss aspects of visual and bulletin board design. A video scrapbook of student's best bulletin boards is compiled each semester for student reference. Students have the option of dubbing the scrapbook to their own videotape.

Students at ESU develop visual and audio interpretations of various poems using still video and audiotape. Working in small groups of four or five members, students use *Cannon Zapshot* still video cameras to record visuals they have created to interpret a poem. Students use *Dukane* audiotape recorders to record the narration and accompanying sound effects. Students present these interpretations in class by advancing the video pictures in synchronization with the audiotape. The audio and video of exceptional presentations are edited together and included in the video scrapbook.

The use of videodisks is increasing in the K-12 classroom. It is a relative inexpensive technology whose use closely resembles playing a videotape. Because of this resemblance, it is one technology that teachers rapidly become comfortable with after initial instruction. Students at ESU use videodisc technology in their final presentations. Students design and present a ten minute lesson that incorporates content from one or more videodiscs, two overhead transparencies, and a minimum of one other form of media. Content is developed and media selected based on the goal and objectives of the lesson.

Students storyboard their lessons incorporating barcodes that they have created using *Bar N' Coder* software from *Pioneer*. The evaluation of students' presentations is based on the design of their lesson, their selection of media, and their presentation skills using the technology. This requirement will be incorporated at USI as the resources become available. Currently USI students review two videodisks and three CD-ROM selections as an introduction to the equipment, and as a vehicle to evaluate software offered in these formats.

Integrating Technology in Teacher Education

Course evaluation and design are ongoing processes at both universities. One of the weaknesses of the previous media programs at each university was the tendency to use the media for its own sake, rather than incorporating it into a master plan. At USI it is being considered to include the instructional technology course as part of a block of core courses. Benefits for students and instructors would be: (1) collaboration among instructors in implementing instructional technology in the various disciplines; (2) a consistent format for writing instructional objectives and designing instruction; (3) modeling of teaching and learning with technology in courses other than the instructional technology course; and (4) a collection of software that has been selected based on instructors' expertise in the various content areas.

At ESU extensive staff development is being used to prepare faculty to use technology in their courses. Focus groups provide faculty with hands-on training using presentation, graphic, digitizing, editing, barcoding and authoring software. Faculty also gain experience in using videodisks, still and motion video, and setting up hardware such as liquid crystal display panels and videodisk players.

Rather than media being the exclusive territory of a media teacher, it is necessary, as part of the current information explosion, for every teacher to incorporate media and multimedia into their instruction if it is to be used effectively. At both universities our philosophy is to share information about technology. Using advanced media and instructional technology effectively is recognized for what it is; an on-going change process that must begin at the university level and continue into the public schools. Students who develop a comfort level with instructional technology and use it effectively become teachers who will do the same. It is our goal to produce future teachers who recognize good instruction and effective instructional methods. It is also our goal to graduate teachers who will use media not for its own sake, but because it is a vital component of their master plan of instruction.

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Lesson Planning with Technology: Use of an Instructional Design Database and Tutorial

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This paper describes the development of a program with *Authorware* (1993) that is both a tutorial and database for an undergraduate instructional design course in which students learn to apply Gagne's Hierarchy of Learning Outcomes to lesson planning and development (Gagne, Briggs & Wagar, 1992).

Title III Grant

I developed this product as a participant in a U. S. Department of Education Title III grant program awarded to Eastern Washington University. The purpose was to develop a group of faculty experts in authoring and integrating multi-media into university undergraduate courses. Over five summers, twenty-five faculty will have participated in the training program and helped colleagues in their departments to develop multi-media instructional modules. The grant provides a summer salary stipend of $5000 for each faculty for product development and partial release time (equal to one course) for one quarter during the following academic year for field testing.

The selection process for participation called for a 5 page narrative to support self-perceived strengths identified in five areas: (1) a description of one's computer skills (2) an explanation of involvement with multi-media; (3) an indicator of knowledge of multi-media available in one's discipline; (4) a statement describing a multi-media project to be developed; and (5) a statement describing one's understanding of the effort and time commitment required to develop a multi-media project.

Participants used Macintosh workstations that included access to videodisc players, CD-ROM drives, cam-corders, scanners, and two projection panels. Electronic demonstration stations on wheels were acquired for distribution to each of the six colleges of the university for use by the participants.

Faculty attended daily four hour sessions for eight weeks. Instruction in both instructional design principles and computer programming was provided. The grant called for providing release time for a computer science faculty member to conduct the training and for hiring two computer science students to assist. The students wrote many of the sub-routine programs for the faculty, such as providing record keeping for student log-ons and responses to interactive questions, thus relieving the faculty of "heavy" programming so they could concentrate on the content of the program.

Instructional design principles were followed that emphasized problem definition, task analysis, development of objectives and selection of appropriate instructional strategies and materials. Implication of research findings were applied to the design of instruction, as well as design of materials, taking into account such factors as learning hierarchies, instructional sequencing, graphic design, and screen display. Steinberg's (1991) work relating instructional design principles to software development was particularly informative.

So far, fourteen projects have been developed. They include: animation software to display organic chemical reactions; HyperCard stacks on mechanical and punctuation errors for a writing laboratory; interactive video and computer sequences for training counselors; a program demonstrating direct and alternating electrical currents; a geology catalog of scanned images of minerals, rocks, and fossils; a tutorial to identify language disorders with examples of interviews for analysis; software for music appreciation, arrangement, composition, ear training and recording; an interactive video demonstrating molecular modeling, dynamics and mechanics of protein structures; a graphical display and analysis of statements using the Repertory Grid technique; a tutorial about literary devices; an introductory biology program to identify bacteria; a program to identify parts of the heart; and a program demonstrating data collection for use in a research methods class.

Instructional Design Program

I developed an instructional program in Authorware to help teacher education students think about instructional design. The user enters the tutorial program by selecting a type of learning outcome (intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes) from a pull-down menu. For each type of outcome, the user then selects from several categories: (1) definitions and examples of the type of outcome, (2) developing objectives with appropriate verbs and evaluation items for the type of outcome, (3) recommended instructional strategies, (4) media format (i.e., still graphics, motion, sound, text) suggestions for the type of outcome. Each of these categories include verbal descriptions of the concepts and examples incorporating sound, graphics, or video, as appropriate. The user can proceed through these categories for the outcomes in a linear manner as a tutorial since there are also practice exercises in which students identify examples and non-examples of the concepts.

A second way this program is used is as a lesson planning tool. After the student has identified content to be taught and analyzed the types of learning outcomes necessary for that content, the program is used as a reference database for lesson planning. For example, if the type of learning outcome involves an intellectual skill, such as abstract concepts, then the abstract concept section can be reviewed as the student develops learning objectives, selects evaluation modes, instructional strategies and media. The organization of material in this program is in contrast to typical instructional design texts that organize information by steps of the process, rather than by type of outcome.

This program is also used in class as a lecture demonstration so that teaching with technology can be modeled. This program allows the instructor to reduce the amount of equipment and materials normally used to illustrate concepts of the hierarchy and has increased efficiency in demonstrating media formats. Subsequently, students use the program in a computer lab which gives them a further opportunity to learn with technology. This integrated program allows students to review the visual examples demonstrated in class, which was not always possible with traditional media.

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HYPERMEDIA/MULTIMEDIA

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Every year, the diversity in the articles submitted for the hypermedia and multimedia section of the STATE Annual continues to grow. As new technologies are incorporated into educational settings, the research into the use of these technologies continues to be both enlightening and diverse. Additionally, the inclusion of technologies into the curriculum, which only a few years ago was considered to be cutting edge, demonstrates both a willingness for change and an amazing ability to adapt technology for its best fit. We are fortunate, as educators and consumers of these technologies, to find that we are becoming increasingly comfortable with the technologies which fall into the categories of hypermedia and multimedia. Yet we must never become complacent with the utilization of technology. As you will see in the following articles, we must continue to question how we utilize technology in our classrooms. The authors have raised many interesting and important issues.

Abate and Hannah have worked with a videodisc presentation utility. The faculty at Cleveland State has begun to incorporate videodisc-based materials into their classroom lessons. The insights, by the authors, into the need for technology to be accessible provide an interesting context for the other articles in this section. Atkins, in her article, has provided an example of one rapidly growing area of technology use: videodisc/videotaped-based model lessons and programs. Many educational institutions have begun utilizing this form of preservice and inservice instruction. Of particular interest is the capability of instructors to utilize a BBS in order to interact and receive additional information. Benghiat and Abate describe the use of videodisc-based instruction in a graduate education class. The positive feedback from the students once again emphasizes the need for technology to be easy to use to be both accepted and utilized. Byrum has developed a program that addresses an issue many technology educators face - how to instruct students in the different types of educational software. The ability for his program to describe each type of program and provide real-time examples should prove beneficial to many college and university educators. Garzone and Bosch have also developed HyperCard stacks for use in the classroom. These programs serve a vital need when we, as educators, find ourselves forced with growing class sizes. Through the use of programs such as HyperCard, instructors can now more easily develop materials which can then be used by students outside class, and thereby come to a better understanding of the material. King and Larkins, and King, Dalmas, Kendall, Miller-Selvage, Welsh-Charrier and Noretsky, in their articles, have addressed an area in which much more work needs to be done. The use of technology in special education has enormous potential. The panel discussion at STATE should prove to be of enormous interest to all educators. Land, in his article, has provided a method for those who program in HyperCard to "remember" to keep an original copy of a stack which they may be modifying. Additionally, he requests that we remember to continue sharing information and materials with other users, so that programs/scripts we have found useful can benefit

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others.

Norman's paper describes a program being utilized in a prototype electronic classroom at the University of Maryland which shows potential for providing a model for others who wish to incorporate a total technology environment into the classroom. The combination of many types of technology and the ease to which these technologies can be accessed offer an exciting picture of the classroom of the not too distant future. Picciano discusses a multimedia model for teaching social history. Of particular interest are the comments from both the faculty and the students who used the program. Once again, we see ease-of-use as an integral step for those developing technology-based instruction. Rubio discusses an issue which may often be overlooked in the area of interactive multimedia - the effects of interactive multimedia on the adult learner. His point that there may never be a fully generalizable set of design principles raises an important issue that deserves further study. Settlage discusses a sometimes overlooked potential for interactive videodisc use in the area of promoting whole class discussion.

As we are seeing in these articles, many interesting uses are being made with interactive video. It has become an accepted part of the classroom and is now becoming a common tool in the curriculum. Swartz, in his article, reminds us of the potential of these new technologies. By allowing the user to become more involved with the message, potential new learning situations can occur. Taylor discusses the development of a hypermedia portfolio. The ability of this portfolio to change with the needs and capabilities provides a good example of the flexibility of many hypermedia-based programs. And the last article, by Valmont, discusses an exciting "new" technology: CD-ROM-based children's literature. His guidelines for this technology provide a valuable checklist for those who are interested in this media.

The authors of these papers have provided insights into the various workings of technologies in the classroom and in the real world. We still have much to learn on this technology highway. Fortunately, we have just found the on-ramp!

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Experiences with a Videodisc Presentation Utility

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Cleveland State University has a long term commitment to instructional technology. This commitment has provided faculty members in the College of Education with numerous opportunities to improve the instruction of preservice teachers. A key component of this commitment includes assisting faculty with integrating technology into their teaching. Several faculty are currently enhancing their lectures using videodisc materials in combination with computers, video projection devices, and simple presentation software. The presentation software used to create video segments is modest in design. The software provides the education faculty with a simple interface for creating presentations from previously developed videodiscs.

Originally, the presentation software was incorporated into a multimedia database (Abate & Benghiat, 1992). The multimedia database provided connections among the text materials presented in specific courses, personal comments provided by teacher practitioners, and videos of classroom lessons. By design the multimedia database supported individual, small group, and large group use and contained the potential for innovative approaches to instruction. In practice, lack of adequate lab facilities, lack of experience with technology, and a long tradition of expository teaching limited the use of the multimedia databases.

The most commonly used feature of the multimedia databases was a video presenter. Using this feature an instructor could select video segments and display them to a lecture audience. The problem with this feature was that it was embedded in a database that appeared rather complex to the typical faculty user. Users were required to understand the Macintosh interface in order to find the video presentation features. Many of the faculty were not familiar with using a mouse or a graphic user interface with pull down menus. As such, it was difficult for them to access and use the presentation feature. The video presenter was rewritten as a stand alone application. This change minimized the amount of effort required by faculty to integrate the video presenter into their courses.

Faculty members teaching with lecture-based course materials were targeted for individual development of video presentations. Previous experience with instructional software development indicated that the success of the software would be influenced considerably by faculty acceptance of the materials produced. (Hannah & Abate, 1993) As such, faculty members were encouraged to participate in the development of the video presenter software.

Video Presenter Features

The first version of the video presenter included features such as text overlays. A text overlay, used as a title or segment description, could appear prior to a video segment or during an entire segment. This version of the video presenter also supported creating segments by clicking on "mark start" and "mark end " buttons while previewing video segments. Although these features appear useful on the surface, the faculty did not use them. The faculty became confused at times on how to use the software due to the clutter these features added to the video presenter screen.

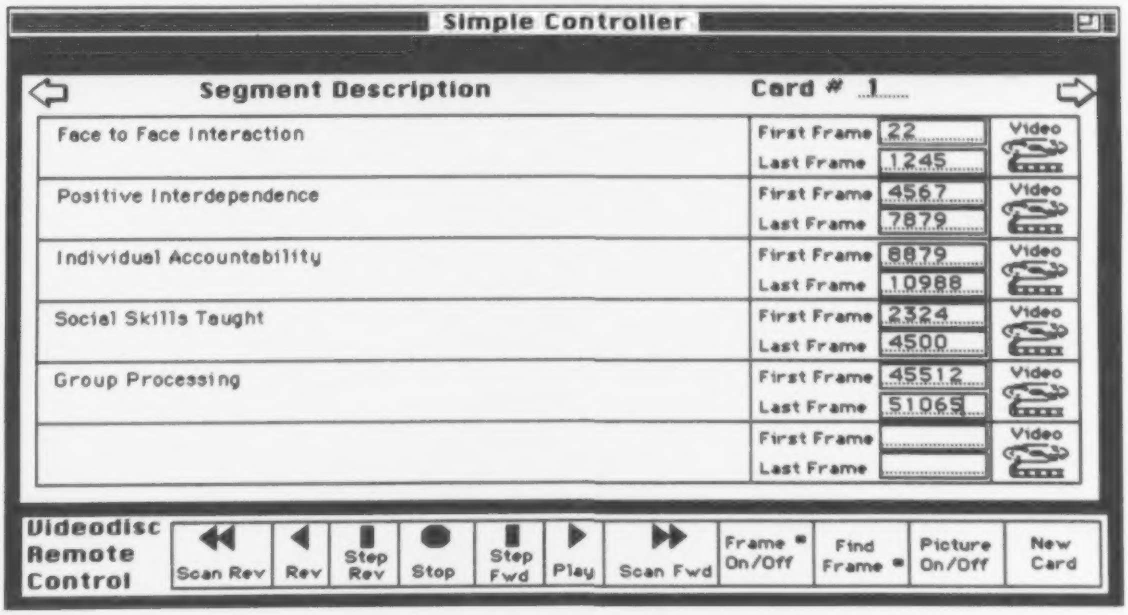
Threrefore, these features were dropped to simplify use of the software.

The current version of the video presenter is a HyperCard stack titled "*Simple Controller*". This stack automatically initializes a videodisc player when you open the software. Automating the start up process gives the faculty one less issue to deal with when presenting in front of a class. The *Simple Controller* informs the user if the player is attached, is on, and if it contains a videodisc. Each card on the *Simple Controller* stack consists of six video buttons, six start frame fields, six end frame fields, and six fields for entering segment descriptions. (See Figure 1) At the bottom of each card are seven remote control buttons. Each button is labeled and the labels are comparable to the ones found on a VCR remote control. Clicking on a button initiates the labeled action. Four additional buttons are provided for control purposes. The Frame # On/Off button is used to display frame numbers from the videodisc on the video monitor. Users identify first frames and last frames using this button. The frames are then typed into the appropriate First Frame and Last Frame fields provided beside individual video buttons. When clicked, the Find Frame # button requests a frame number from the user, searches the videodisc for the frame number and displays that frame on the video monitor. It is typically used when previewing materials and making decisions. The Picture On/Off button replaces the video signal with a blue screen. This button is typically used during lecture to return student attention from the video to the lecturer. The New Card button lets the user create additional segments. Thus, the user is not limited to six segments per presentation.

Creating a presentation

In general, video presentations are produced through a series of simple steps. First, a faculty member identifies portions of a lecture that could be enhanced through video examples. Next, this information is shared with a member of the College of Education Videodisc Project team. The project team member identifies general video segments from one of thirteen different lessons stored on videodiscs. Attempts are then made to find as many segments on each videodisc lesson as is possible. The rationale behind limiting segments to one videodisc is a practical one. Changing videodiscs during the middle of a presentation requires pulling a videodisc out of a videodisc player, and reinitialize the videodisc player. This increases the time required to make the presentation and disrupts the continuity of the presentation. After the general videodisc segments are identified, the faculty member previews the segments using the remote control features located on the video presentation software and enters the specific frame numbers and segment descriptions into the appropriate fields. Once all the desired segments are entered the software is ready for classroom use. For example, in the first entry in Figure 1. the user has typed a description of a segment on "face to face interaction" from a cooperative learning lesson. This segment begins at frame 22 and ends at frame 1245. The first and last frames were typed into the corresponding first and last fields. To view this segment the user clicks the mouse on the Video button to the right of the fields and the segment begins to play.

In other instances, the user may create a presentation using the software and then transfer each of the segments to



Simple Controller

Card # 1

Segment Description			
Face to Face Interaction	First Frame 22	Last Frame 1245	Video
Positive Interdependence	First Frame 4567	Last Frame 7879	Video
Individual Accountability	First Frame 8879	Last Frame 10988	Video
Social Skills Taught	First Frame 2324	Last Frame 4500	Video
Group Processing	First Frame 45512	Last Frame 51065	Video
	First Frame	Last Frame	Video

Figure 1. HyperCard Simple Controller for Videodisc Player.

videotape for classroom presentation. Three basic reasons were identified why some faculty members prefer to have their videodisc presentation transferred to videotape. One reason was a phobia of the computer/videodisc player/video projector arrangement. Given the numerous wires and cables, their concern is reasonable. The second reason identified was limited access to the videodisc equipment. Not all classrooms on campus have easy access to the computer/videodisc player/ video projector arrangement but most classrooms on campus have some form of access to videotape. In addition, some classes are taught off campus. In these instances it was simply not feasible to use the videodiscs. A third reason cited by faculty arose in situations that required changing videodiscs in mid-presentation. One benefit of using the videodisc is rapid access to video segments. Changing videodiscs during mid-presentation eliminates this benefit. Fortunately, Cleveland State holds the copyright to the video materials recorded on the videodiscs. As such, there are no legal issues to contend with when transferring the video segments to videotape. In addition, encouraging faculty to create their own tapes has led to increased familiarity with the technology. This in turn has increased both usage and interest in the existing videodisc materials.

Advantages and Disadvantages of the Presenter

Investigations into the use of videodiscs suggests that they may provide a way to improve student comprehension of content by anchoring instruction in real problem situations (Sherwood, Kinzer, Bransford, and Franks, 1987). Practical experience suggests several advantages for including the use of the videodisc examples along with expository teaching. Comments from faculty suggest that students' understanding of concepts, methods, and strategies presented in class are enhanced by providing examples of exemplary teaching. Each lesson segment provides a common frame of reference that includes highlights of the key teaching attributes identified in the lecture. As such, class discussions are more meaningful now that the students have a common context to refer to.

Field experience is a key component of the preservice teacher education program at Cleveland State. However, not all field experiences are comparable. The faculty who use the video presenter have reported that the videodisc lessons offer more controlled experiences. In addition, the videodisc lessons assist in teaching the students how to observe teachers in the field.

In addtion, the faculty hold that it is important to model quality teaching in the preservice program. The video presenter has provided a practical way for the faculty to model the appropriate use of technology in the classroom.

Despite the perception of these advantages, several factors that made it problematic for faculty to use the software were identified. The problems fit into two categories; technical and content. On the technical side, a common and justified complaint was that the equipment was too cumbersome. To present in a classroom, the instructor was required to wheel a cart from a computer lab to the class, which might be in another building. The cart included a videodisc player, a speaker, a computer, an LCD display, a video projector, and a seemingly endless mass of cables. Even seasoned computer users found the mass of equipment somewhat overwhelming.

Many of the classrooms are not designed for video projection. In these classes the faculty member was required to disconnect the video and connect it to in-class video monitors. The in-class monitors provide an image that is considerably smaller than that provided by the projection device. In addition, the quality of the video image presented on the monitors is diminished.

One of the most disconcerting problems stemmed from increased use of the equipment. The computer/videodisc setup was used for many courses and it was not uncommon to discover a few minutes prior to class that needed software had been unwittingly removed by a prior user.

Content problems revolved around two related issues; only a limited number of video examples were available and a considerable time commitment was required to create new materials. The latter problem was compounded by the reality that faculty are not provided with either the time or incentive to create additional examples.

Summary

The video presenter program represents a small portion of the technology-related instructional materials developed for use in the preservice education program at Cleveland State. The video presenter went through several revisions before an acceptable product was produced. The mandate advanced by faculty was "make it simple to use." Technically the software was neither complicated or impressive. However, it has proven impressive in that is has altered the way some faculty view technology. Based on the experience of developing and implementing the video presenter, it may be argued that the old adage "All things being equal that which is simplest is best," applies to videodisc technology as well. The simplicity of the program has encouraged some of the faculty who were not interested in technology to examine how technology might improve their teaching and it has provided a means for getting them started.

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Creating Images of Model Elementary School Mathematics Programs

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The *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) describes a new vision of school mathematics. This vision seeks to actively engage students in the learning of mathematics: "learning mathematics is doing mathematics." Learning mathematics is no longer considered to be the memorization of facts and procedures but is the exploration and construction of patterns and relationships (Everybody Counts, 1989; Steen, 1990).

The view of the learner of mathematics has also changed. The mathematical world of the learner involves engaging in problem solving activities, communicating mathematically, and reasoning mathematically (NCTM, 1989). The student is no longer viewed as a passive receiver of knowledge but is the active participant in the construction of his/her own knowledge. In this context it is assumed that, "a student's mathematical actions or explanations are reasonable from his or her point of view" (Cobb et al., 1991, p. 7). These actions or explanations are viable constructions until a conflict arises between solutions or understandings. Through seeking resolution to these conflicts learning occurs (Cobb et al., 1991).

Where does this leave the teacher? The teacher is no longer the authority figure in the classroom but serves as a facilitator/resource person. Cobb et al. (1991) describe an alternative way in which a teacher can express his or her authority in action:

> The teachers' role in initiating and guiding mathematical negotiations is a highly complex activity that includes highlighting conflicts between alternative interpretations or solutions, helping students develop productive small–group collaborative relationships (Wood & Yackel, 1990), facilitating mathematical dialogue between students (Wood, Cobb, & Yackel, 1989).

It is the teacher's responsibility to provide potential learning experiences in which students can construct mathematical understandings.

Accompanying the changing views of mathematics and the teaching and learning of mathematics is the role of assessment in the mathematics curriculum. Traditional paper and pencil quizzes and tests no longer "fit" this new vision of school mathematics. Consequently, alternative forms of assessment have become a popular topic at professional meetings, inservice workshops, and education classes. These alternative forms of assessment include observation, interviews, conferences, performance assessment and portfolios (Stenmark, 1991). Each is designed to provide the teacher with insights into the mathematical constructions of his or her students.

Implementing a New Mathematics Curriculum

The successful implementation of the school mathematics curriculum described by NCTM requires present and future teachers to create a new image of the mathematics classroom. Unfortunately, the previous experiences of current and future teachers do not provide these individuals with an image of school mathematics described above. That is, the ways in which these individuals learned mathematics and experienced the teaching of mathematics is representative of the "traditional" school mathematics curriculum (Barron & Goldman, 1992). These individuals have strong images of memorizing facts and procedures, completing pages of drill and practice activities, and working individually in the mathematics classroom. As a result they have constructed a strong image of a teacher's role in a "traditional" mathematics classroom. However, creating a new image of school mathematics requires preservice and inservice teachers to shed previous conceptualizations of teaching and learning mathematics and to construct a new image in which their role and the students' role is redefined.

Why Interactive Video?

As a teacher of mathematics methods courses, I have found the creation of meaningful experiences in which preservice teachers can create an image of their role in teaching mathematics, both challenging and frustrating. The mathematics department has sought to redesign the mathematics courses for elementary education majors to be supportive of the mathematics described in the *Standards*. That is, instructors of these courses seek to model effective mathematics instruction outlined in the *Standards*. In addition, problem solving is emphasized throughout the mathematics curriculum.

The mathematics methods course has been designed to continue modeling effective instructional strategies supportive of the *Standards*. In addition, preservice teachers are provided with a variety of experiences, both in the university setting and in the urban elementary school setting, designed to support curricular changes in the community. Although the students have experiences with cooperative learning, problem solving, alternative assessment, and technology, they do not have an image of how these components fit together. That is, the methods students are struggling to reconcile preconceived notions of their role as a teacher with the role described to and modeled for them in their mathematics and mathematics methods courses. They are struggling to create an image of teaching mathematics which incorporates all of the above mentioned instructional techniques.

The time limitation inherent in a one-quarter methods course further complicates the creation of experiences which can assist in the construction of an image of teaching mathematics. Consequently, I turned to the Videodisc Project Team at Cleveland State University. I hoped that we could create a series of videodiscs and videotapes containing model mathematics lessons and programs. These videodiscs and tapes would then become an integral part of the methods course to provide an image of this "new" school mathematics curriculum.

The topics chosen for videodisc production were influenced by the mathematical reform activities of the university and the surrounding school systems, in particular the reform efforts of the Cleveland Public Schools. Five aspects of school mathematics were chosen as potential videodisc topics: problem solving, parental involvement, mathematical competitions, new curriculum implementation, and students with special needs. Each of these topics is receiving increased attention in the Cleveland Public Schools and the surrounding school systems.

Problem Solving

Engaging students in mathematical problem solving is the focus of the mathematics curriculum described in the *Standards*. With the support of the Cleveland Collaborative for Mathematics Education, a Problem Solving Bulletin Board has been established for use by all schools with telecommunications capabilities in the Cleveland area. Each week five problems are available for each of four levels: lower elementary, upper elementary, intermediate school, and high school. Teachers and students are able to get copies of the problems and submit solutions via a modem. Although this is a free service, few teachers have incorporated the bulletin board problems into the mathematics curriculum. Consequently, the first component of the videodisc and videotape materials provides users with a model for effectively engaging students in collaborative problem solving.

Parental Involvement

Changes in the mathematics curriculum and the utilization of alternative assessment techniques have raised concerns among many parents. As with teachers, the previous experiences of parents in the mathematics classroom are quite different from the "new" school mathematics curriculum. They have many questions regarding the lack of worksheets, quizzes, and tests. In addition to the need for informing parents of the changes taking place in the mathematics curriculum, parental inclusion in the mathematics education of their children is receiving increased attention. Parents often influence their children's conception of their ability to be successful in mathematics and in pursuing mathematics related careers (Booth, 1992). In that Cleveland State University is an Equals/Family Math site. We were able to utilize the Family Math staff in the creation of videodisc materials which show parents and teachers working together to learn effective ways to engage children in mathematical activities at home.

Mathematical Competitions

The use of mathematical competitions to enhance the school mathematics curriculum is a third component of the videodisc materials. A buzzer system competition, used at a local elementary school, is the focus of this segment. Preservice and inservice teachers will be provided with a visual image of elementary school students excited about participating in a mathematics competition.

New Curricular Adoptions

Accompanying the growing influence of the *Standards* on the school mathematics curriculum is the creation of textbooks and materials supportive of needed curricular changes. This year the Cleveland Public School System adopted the Mimosa textbook series for grades K–3. This series provides a communication approach to teaching mathematics which is supportive of both mathematics reform endeavors and the use of whole language in the elementary school mathematics curriculum. Through using videodisc and videotape materials the project team hopes to provide both preservice and inservice teachers with models for teaching lessons from this new text at a variety of grade levels.

Students with Special Needs

A final component of the materials will be examples of including students with special needs in mathematics lessons. The methods course is required for students seeking certification in teaching the developmentally handicapped. However, few examples of implementing the *Standards* with students with special needs exist.

Perceived Uses of the Materials

Both the videodisc lessons and videotape lessons will become an integral part of the mathematics methods courses. Students will be provided with opportunities to view classroom teachers and school children doing the mathematics described and modeled in class. In addition they will be provided with visual images of strategies for engaging parents in the mathematics education of their children and the inclusion of students with special needs. The materials will also be available to teachers and administrators in the surrounding districts for use in inservice programs on mathematics education.

Conclusion

Each of the five components of the videodisc/videotape materials was chosen to support national, state, and local mathematics education reform. Although the target audience was initially the students in the mathematics methods courses at Cleveland State University, we have found that inservice teachers and school administrators are interested in using the materials to enhance their reform efforts. It is hoped that through the use of videodisc/videotape technology the large number of preservice and inservice teachers at the university and in the surrounding school districts can begin to create a vision of their role in the changing mathematics classroom.

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Planning and Implementing a Videodisc-Based Observation Program

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Secondary teachers have long been aware that the integration of a variety of student reading and writing tasks in the instruction on content is essential to student understanding of the material. The realities of the classroom, however, can place constraints upon the best of teacher intentions, and often little or no student reading or writing takes place during extended periods of class time. In planning for a graduate course in reading and writing in the content areas, the Cleveland State University faculty member responsible for the course determined that observations of the amount and kinds of reading and writing actually taking place in real content area classrooms would provide students with insights into existing classroom practice. These insights could then be used by graduate students to develop inservice programs to facilitate change.

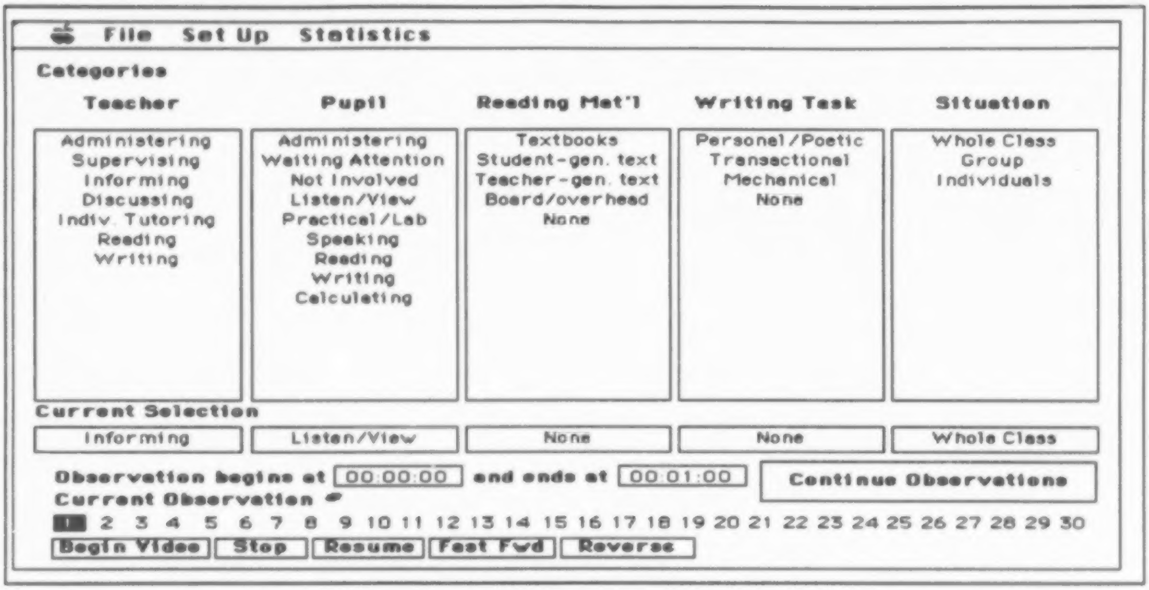
Initially, the graduate students enrolled in the content area reading and writing course were asked to seek out secondary content classrooms to observe and then asked to complete observation inventory forms in these classrooms during at least one full class period. What seemed to be a simple course assignment was fraught with unforeseen complications. Most of these graduate students are practicing elementary and secondary school teachers. Although the secondary teachers had little trouble finding a class to observe in their buildings, they had difficulty clearing time in their teaching schedules to finish the task. Elementary teachers had trouble finding a suitable class to observe and even more trouble clearing time in their work days to leave their buildings and carry out the assignment.

When the observations were finally completed, a new set of problems emerged. As the graduate students shared their observations with their classmates, it became apparent that translating the wide variety of experiences into one clear picture of classroom practice was time consuming and cumbersome. Furthermore, the students' lack of experience with observational research and the instructor's limited knowledge of the classrooms where the observations took place made the assignment even less useful. The idea looked good on paper but was plagued by practical problems, and the instructor considered abandoning the observation assignment.

Planning the Videodisc Materials

The problems related to the observation assignment were explained to the College of Education Videodisc Project. The project team had spent the previous four years developing hypermedia instructional materials for undergraduate and graduate education courses. After a number of brainstorming sessions, the instructor and project team came up with a plan for using technology to make the assignment more viable. First it was decided to separate the graduate class into content area groups (social studies, science, English, mathematics), and to provide each group with a secondary classroom in their content area to observe via videodisc.

A Greater Cleveland eighth grade teacher from each of the four content areas agreed to be videotaped for the observations. The teachers were asked to teach their regularly scheduled lesson for the taping and to keep the



Teacher	Pupil	Reading Mat'l	Writing Task	Situation
Administering	Administering	Textbooks	Personel/Poetic	Whole Class
Supervising	Waiting Attention	Student-gen. text	Transactional	Group
Informing	Not Involved	Teacher-gen. text	Mechanical	Individuals
Discussing	Listen/View	Board/overhead	None	
Indiv. Tutoring	Practical/Lab	None		
Reading	Speaking			
Writing	Reading			
	Writing			
	Calculating			
Informing	Listen/View	None	None	Whole Class

Observation begins at 00:00:00 and ends at 00:01:00

Figure 1. The Observation Form.

lesson as close to a half an hour as possible. Two cameras were used for the taping, one following the teacher and providing a wide shot of the classroom and the other supplying a close up shot of a group of students. Minimal editing was done to provide the graduate students with a realistic observation of the types and amount of reading and writing in the class while establishing the teacher's role in the lesson. The final edited tapes focused primarily on the students. Each of the final tapes was pressed on to separate videodiscs.

To ensure complete, accurate, and consistent observations and a rapid and accurate tabulation of data, *Observer*, a specially designed observation inventory program was created. Using the Reading Behavior Inventory Form, a type of interaction analysis developed by Dolan, Harrison, and Gardner (1979) as a model, Dr. Jane Zaharias of the College of Education at Cleveland State developed a special observation form for the *Observer* program. The main goals of the computer program *Observer* are to enhance students observational skills and to provide an awareness of classroom practice. The program addresses these goals in the context of controlled observation, providing an environment that eliminates many of the problems associated with field observations. The program runs on a Macintosh LC computer. Additional requirements include a Pioneer videodisc player and a video monitor.

During initial program design, a decision was made to simplify student interactions with the computer so that the students could concentrate on the meaning of the observations rather than the complexity of recording observations. It was anticipated that some of the students would be familiar with the Macintosh user interface. For this reason it was decided that the *Observer* program would conform to the Apple user interface guidelines. All student interaction with the program would be accomplished through simple mouse actions. Limiting control to mouse actions relieved students of the need for keyboarding skills or knowledge of control key commands.

Program Specifications

The final version of the program consists of three screens. The Observation Form used to record observations serves as the opening screen. A second screen, Current Results, accessed via the Statistics Menu, provides a snapshot view of all recorded observations. A third screen, Current Frequencies, displays the number and proportion of responses according to category and type.

The Observation Form allows students to select from five categories of actions: a) specific teacher behaviors; b) specific student behaviors; c) reading materials used; d) writing task; and e) the class grouping situation. (see Figure 1). Each category on the form contains a listing of possible observations. Students are directed to set a one minute time interval for each observation. To record an observation students use the moust to point to the desired description and then click to select it. The selection then appears in the appropriate Current Selection box provided below each category listing. The Current Selection boxes were added to the program after initial prototype testing. A student must select one action from each category for each interval in order to continue the overall observation. In testing it was common for a student to overlook a category in an interval. However, the *Observer* program does not let the overall observation resume until each category in each interval has a description. An empty Current Selection box cues the student to what category of observation lacks a description.

The student then selects a description for that category. The Current Selection box serves a secondary purpose; students find it reassuring to see their choice verified on the screen before they continue on to the next observation.

In addition to recording observations, the observation form screen provides information regarding the progress of the observation. The numbered boxes at the bottom of the screen indicate what the current observation interval is and how many observations remain. Finally, this screen provides control buttons which let the students examine the lesson without recording observations.

The decision to provide a picture of overall interactions during the lesson video made it necessary to organize the observations in a manner which would reflect change over time. The original design called for the presentation of a simple grid system which would capture changes among categories, descriptions and time intervals. In the prototype this information was presented concurrently with the Observation Form. Comments from users during testing of the prototypes indicated that the screen display was too complex when the observation form was displayed concurrently with the current results. In addition, users remarked that it was more difficult to select descriptions on the cluttered screen. Therefore, a design decision was made to separate entering observations from viewing overall results. A new grid was designed. Students now toggle between observations of a specific interval and a snapshot of all observations via a Current Results selection provided in a pull down menu.

The final screen quantifies the observations made by the students. For each description in each category a tally is kept of the number of occurrences as well as the proportion of occurrences by category. The Current Frequencies option displays the number and proportion of responses according to category and type. A print results option provides students with both the current results information and the current frequencies.

Implementing the *Observer* Program

Observer's debut was extremely successful. The program was used in a laboratory setting with the course instructor and a proctor from the Videodisc Project present. For the purpose of the assignment, each content area group was divided into two groups so that three students would be at every work station. Work stations consist of a Macintosh LC computer, a videodisc player, and a monitor. Prior to the lab the class reviewed printouts of the Observation Form. A short how-to demonstration of the hardware and *Observer* program was presented to the entire class. Then the students were given the option of watching all or part of their video before they began the actual observation activity. All groups chose to watch a short segment of the video before they returned to the beginning and launched into the observation. Of the eight groups, only one needed assistance in getting started and another requested help in changing an observation they felt they had done incorrectly. Most groups simply wanted reassurance that they were proceeding properly before they completed the assignment on their own.

As they were working, all of the groups commented on how easy *Observer* was to use and how it simplified the observation and recording tasks. Many felt the features of the Current Selection Box and the control they had over the pace of the activity made their observations more accurate and sensitized them to problems they might encounter when doing actual observational research. After the first few intervals were recorded, conversations within the groups shifted from the mechanics of the program to the observation process. All groups completed their observations in 90 minutes, including checking responses, and then requested help in printing out the results. When the smaller groups within content areas compared their printouts, their results were remarkably similar, suggesting that *Observer* is a reliable tool for developing skills in observational research.

In follow-up sessions, the four content area groups reviewed and discussed their printouts. The goal of these sessions was to analyze the data in terms of the amounts and types of reading, writing, listening, and speaking that occur in a typical content area lesson with an eye toward enhancing the delivery of content through strengthening the effectiveness of all of these areas. This information was then used to develop inservice presentations that provide content area teachers with methods for integrating effective reading and writing tasks into daily content lessons with the ultimate goal of providing students with strategies for learning.

Conclusion

Feedback from students using *Observer* for the first two times has been positive, with most praising the program's ease and utility. Some stated that it gave them an excellent introduction to observational research and would be useful to them in research beyond the scope of the content area reading and writing course. The course instructor feels that *Observer* has strengthened her assignment both in facilitating the observation process and in providing consistent, reliable data for her students to work with. *Observer* has become a permanent part of her course, and plans are underway to modify the program for continuing use in a variety of research studies.

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Educational Software Types: An Interactive HyperCard Tutorial

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No other recent innovation in education has the potential or pitfalls of computers in the classroom. When used to potential, computers can be a valuable aid to instruction, stimulating student interest, as well as, a tool for problem solving and simulation. When used at their worst, computers can become electronic flashcards boring students and wasting expensive resources. Studies (Ely, 1987; Koohang, 1987; and U.S. Congress, 1988) have shown that given the vast amounts of software available for instruction, teachers are using programs that primarily involve low level skills and thinking processes (e.g., drill and practice or tutorial software). The primary reason for the underuse of high level thinking programs by teachers is lack of training in instructional software selection. Preservice teachers on the average only view one to three pieces of software during their educational training (Byrum & Cashman, 1993) and do not receive thorough instruction and examples of other types of software such as simulation or problem solving. This paper will discuss a software project developed by the author as a HyperCard™ stack titled *Educational Software: An Interactive Guide to the Types of Educational Software* to teach preservice (or inservice teachers) the various types of software and the characteristics of each. This software project was developed as part of a 1993 Research Enhancement Grant from the Office of Sponsored Projects at Southwest Texas State University.

All students in the Curriculum and Instruction Department at Southwest Texas State University are required to take an instructional technology lab as part of their coursework. This semester long lab covers educational uses of microcomputers as well as other forms of traditional media such as transparencies, laminating, and A-V equipment. Over the years, as much information as possible has been placed into self-paced instructional modules students use in the lab. As part of their technology training on computers, a self-instructional module was being developed by the instructor on software evaluation and software types. An informal software search conducted by the author in the Spring of '93 did not locate instructional software that dealt with the subject area of software types. Therefore, the author decided to continue with development of the *Educational Software: An Interactive Guide to the Types of Educational Software* HyperCard stack.

The types of software covered in the stack are drill & practice, tutorial, simulation, and instructional game. The major advantage to using the HyperCard program is the ability to present the characteristics of the software type and then allow the learner to use that type of software during instruction. For example; after instruction on the characteristics, advantages, disadvantages, and uses of drill and practice software, the learner has the opportunity to use a drill and practice session developed for the program. Although many educational computing textbooks classify software according to the categories outlined previously, none are able to give learners the "hands-on" experience needed within the instruction. It is somewhat ironic that information on using software for instruction is often presented in textbook form rather than using the media it promotes.

The main goal of developing this HyperCard stack was for the students (preservice teachers) to be able to discriminate among the software types of drill and practice, tutorial, simulation, and instructional game. The three major objectives for the stack are to provide:

1. instruction on software types, characteristics, advantages, and disadvantages in a non-threatening manner,
2. students with actual interaction with generic examples of the different software types,
3. the instructors a way to customize the stack for their own use and and their own software types.

General Format

To illustrate more clearly how the HyperCard stack *Educational Software: An Interactive Guide to the Types of Educational Software* functions, several of the screen displays (cards), and descriptions from one section of the program, have been included in this paper. The initial screens of the program explain both what the program is about, provide an overview, and give directions on how to use the program and its various navigational tools. The next section gives a main menu from which the user can choose to receive instruction on either drill and practice, tutorial, simulation, or instructional game. Each software type has instructions that follow a basic format of:

1. A definition of the software type (posed as a question),
2. A flowchart or diagram explaining the basic functions of the type of software,
3. Advantages of the software type,
4. Disadvantages,
5. An opportunity to use the software, and
6. A brief summary of the definition, advantages, and disadvantages.

Sample Session for Drill and Practice

As an example of how the basic format is used, the drill and practice section of the program will be explored in more detail.

Definition of software type

A screen (card) gives a brief definition of the software. The definition is provided as an answer to the question: What is Drill and Practice Software? Drill and practice software is educational software that does not attempt to teach or provide instruction. Drill and practice reinforces through practice and repetition the concepts or skills that have been taught by the teacher.

The author has tried to provide a flowchart that illustrates the operation or characteristics of the software type. The flowchart in Figure 1 for drill and practice software was adapted from Price (1991).

Advantages of the software type

Each software type has specific advantages tied to its format and intended use. When possible, the author consolidated and chose essential advantages when many were available. For an example of the drill and practice advantages please see Figure 2

Disadvantages

The card listing the disadvantages of drill and practice used the same format as the advantages card. Several of the disadvantages included in the drill and practice section are:

- Programs often boring and many students lose interest.
- Appears more like tests to students than instruction or learning.
- Waste of computer capabilities using it as electronic flashcards.
- Does not help students learn how to solve problems only respond to them (low-level thinking skills).

An opportunity to use the software

Each software type also has a short program demonstrating some of the characteristics and formats of that particular type. This allows the learner an opportunity to immediately interact with, compare, and use software types. The author feels this ability is one of the greatest strengths of this program. The drill and practice sample program gives the learner several scenarios with which to interact. The first four cards are mathematics examples in which the student types in the answer to the problem and then clicks on the ball (see Figure 3). After clicking on the ball, the user receives appropriate negative or positive feedback on their response. If the user types in the incorrect answer twice, the program responds with the correct answer. The math examples are followed by four cards of language arts examples in which the student receives practice in identifying verbs and nouns by clicking on the correct word and receiving feedback as before.

A brief summary of the definition, advantages, and disadvantages

At the conclusion of the sample program there is a brief summary of the key concepts to help the student both review and refocus on the characteristics of the software type before moving on to next. The following is the review information for drill and practice software. Remember, drill and practice software:

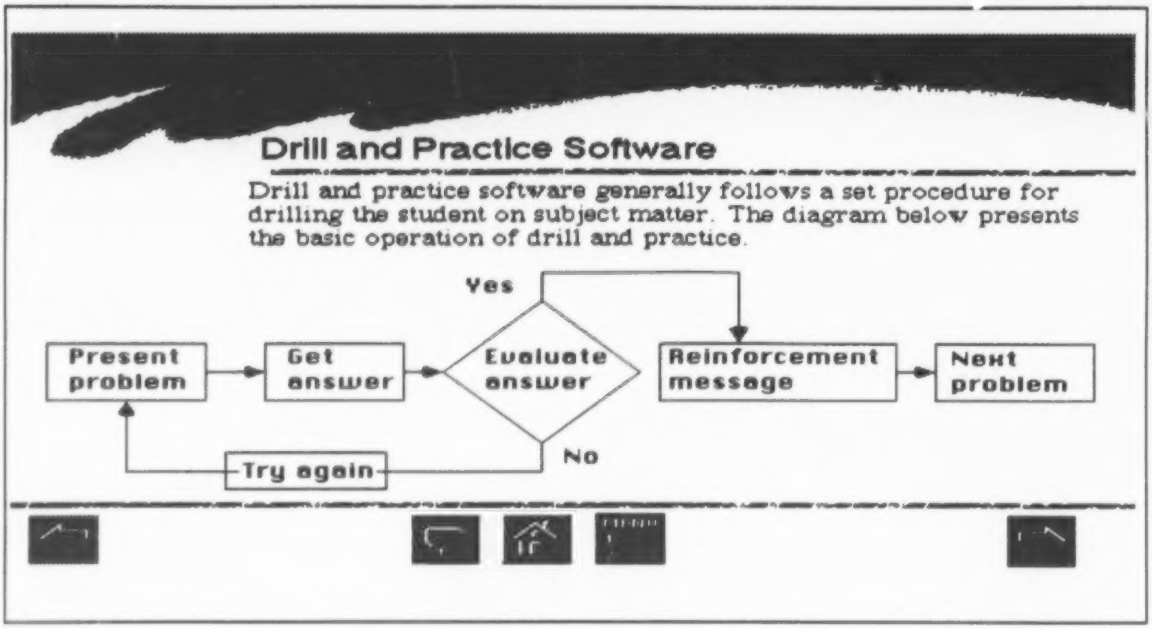
- Does not attempt to teach, it is used only to reinforce concepts and skills.
- Helps promote memorization through repetitive practice and immediate feedback.
- Can be boring and no more than "electronic flash cards" when overused.

Key Features of Other Software Types

The tutorial, simulation, and instructional games software types follow a similar format to that shown in the drill and practice instruction. Space does not allow for a full discussion of the instructional material and programs that go with each software type but a brief overview of key concepts and instructional information is listed below.

Tutorial.

The instructional information includes definitions, discussion, and flowcharts of both linear and branching tutorial software. After listing advantages and disadvantages of tutorial software, the learner interacts with a tutorial program on telecommunications. The telecommunications

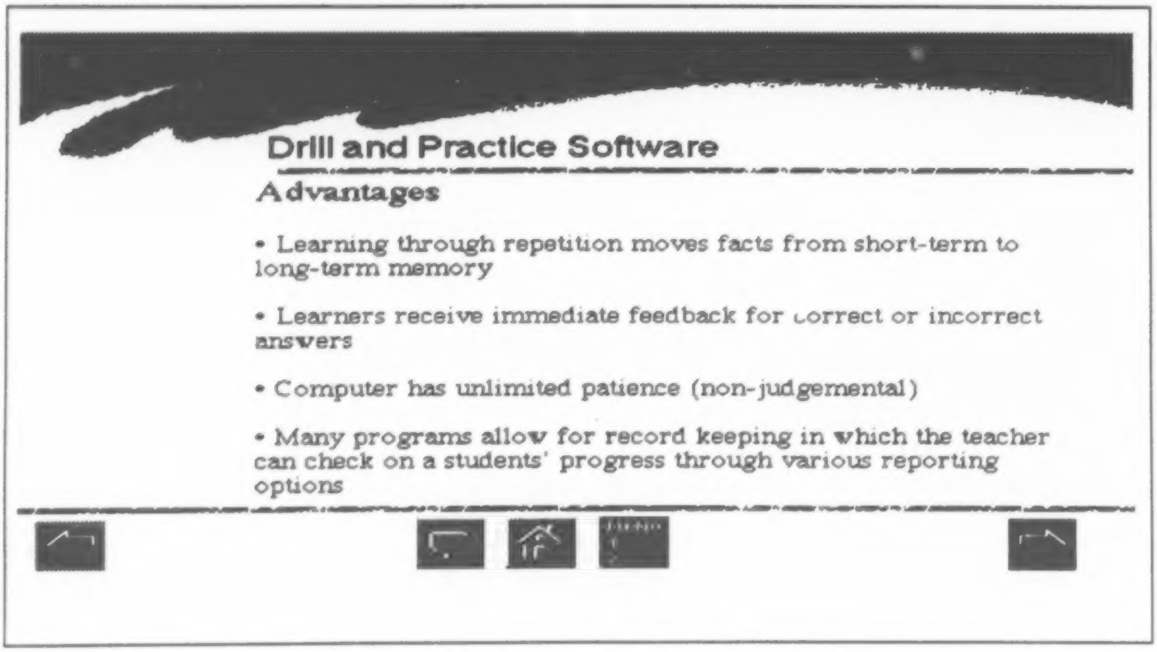


Drill and Practice Software

Drill and practice software generally follows a set procedure for drilling the student on subject matter. The diagram below presents the basic operation of drill and practice.

Present problem
Get answer
Evaluate answer
Yes
Reinforcement message
Next problem
No
Try again

Figure 1. Flowchart of Typical Drill and Practice Software

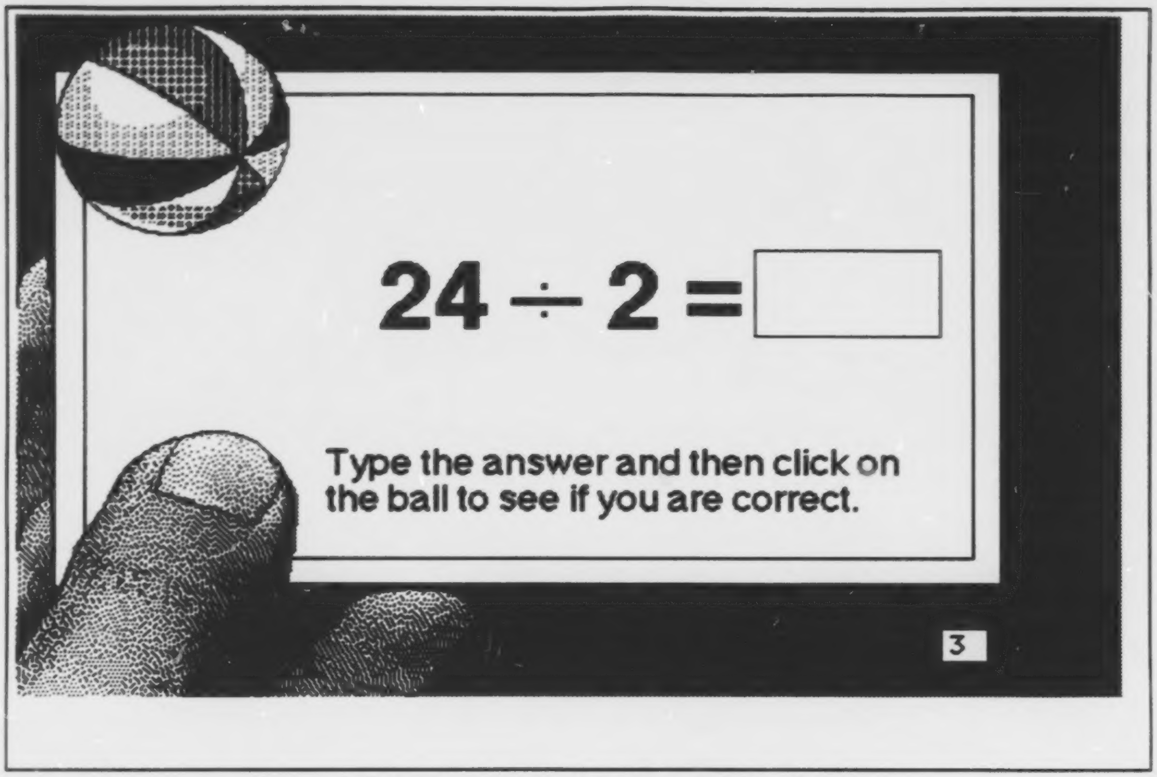


Drill and Practice Software

Advantages

- Learning through repetition moves facts from short-term to long-term memory
- Learners receive immediate feedback for correct or incorrect answers
- Computer has unlimited patience (non-judgemental)
- Many programs allow for record keeping in which the teacher can check on a students' progress through various reporting options

Figure 2. Advantages Card from Drill and Practice Section.



24 ÷ 2 = ☐

Type the answer and then click on the ball to see if you are correct.

Figure 3. Example Screen of Drill and Practice Software.

user to whether the program is going through a linear or branching process so that the learner can compare the two techniques.

Simulation

The simulation section also includes definitions, flowcharts, and advantages and disadvantages. Additional information is given on the various types of simulations and examples of each. The simulation types briefly discussed are: a) physical simulations - physical object or phenomenon is represented on screen; b) process simulation - teaches about process or concepts; c) procedural simulations - teaches a sequence of actions that constitute a procedure; and d) situational simulations - attitudes and behaviors of people in various situations. Students then use a short simulation program and view a summary.

Instructional Game

This section follows the same format as the others. The instructional game is a role playing game in which the learner becomes a detective in order to find out who let the animals out of the zoo.

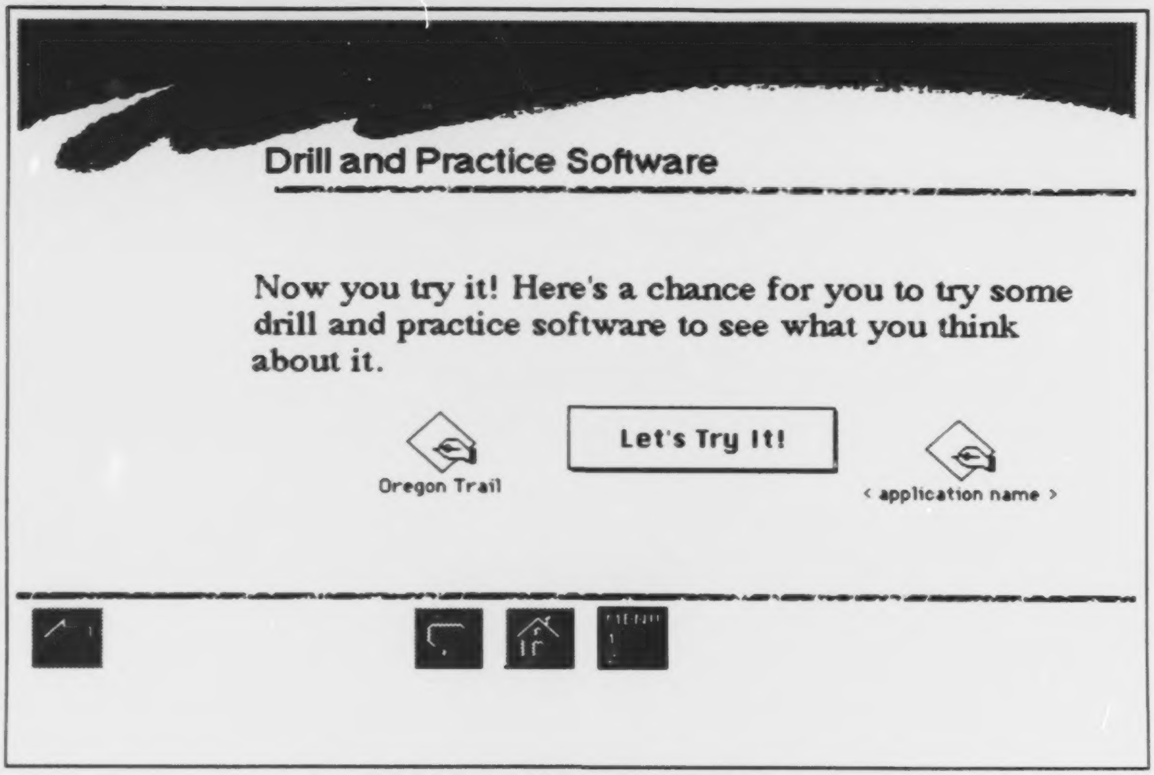
Additional Features

One unique feature built into the stack allows the instructor to use commercial programs rather than the sample programs provided. To use this feature the program you wish to use must be in the same folder as the five stacks contained in this program. On the screen (card) following the instruction for each software type is a button which takes the user to the sample program. In addition to this button is another button that allows the instructor to insert their own program into the menu. For example, if the instructor wished to use *Oregon Trail* as a simulation example, the instructor could place the program in the same folder and add it to the list of example programs. The program will ask where the program is located and then places the chosen program on the menu as the *Oregon Trail* program has been done in the example shown in Figure 4. After using *Oregon Trail*, the program would automatically return the user to the HyperCard stack.

Although no formal evaluation questions have been added to this program, they could easily be added by the instructor at the end of each section or at the end of the program. The author may add this feature along with student identification numbers to keep track of students using the program and their scores.

Acknowledgments/Distribution

The author would like to thank the Office of Research



Drill and Practice Software

Now you try it! Here's a chance for you to try some drill and practice software to see what you think about it.

Figure 4. Adding a Prgram to the Menu.

and Sponsored Programs at SWTSU for financial help and encouragement in this project. Thanks also to Lawrence Medina for research, programming assistance, and creation of the "Detective" stack.

The author would like to make this HyperCard program available at no charge for anyone who wishes to use it in their instructional technology courses or labs. Please contact the author for information on obtaining the program or suggested improvements at the address or e-mail address at the end of this paper

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Two Hypercard Stacks: Design and Delivery to College Juniors

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In response to the needs of college students we developed two HyperCard instructional stacks that address English language topics:

- decayed second person personal pronoun forms and
- shifted long vowels.

These topics are important in modern English (MoE) and relate to New York State Education Department (SED) English curricular goals, specifically language arts objectives for primary, intermediate, and middle school grades. Students in teacher education at SUNY at Oswego pursue either N-6 or N-9 certification. A four semester-hour, required, teacher education undergraduate course, *Curricular Foundations in the Language Arts and Reading*, includes objectives and SED goals related to the content of the two stacks developed.

Problem: Need for Student Self Helps

Over 100 students are in each section of the course which makes conferring with and supporting less able students in small groups either in class or outside class difficult. We identified 12-15 difficult English language structures which relate to the course's three major educational objectives: selected English language history changes; fundamental linguistics systems (phonology, syntax, semantics); literary principles such as four major genres' characteristics: prose fiction, poetry, essay, drama. We developed quizzes that assessed the students' understanding of the 12-15 difficult structures.

Small group help for less capable students was essential, but impossible, with as many as 140 students in a section. We decided, therefore, to create an electronic version of help that might, to some extent, replace the small group help sections that were feasible when the enrollment cap for the course was lower. We selected HyperCard as the development environment.

The HyperCard stacks function as an electronic Rolodex of cards. A team of three authors, including a student intern who was a computer science major, developed a storyboard for the HyperCard stacks. Once the general format of the stacks was defined the intern created a template for cards in the stacks. The other authors then used the template to create the first stack.

Design: Stack One

Twenty-three cards, using button choices (mouse-clicked) and their responses, make up this HyperCard stack target, an English language historical change. Early MoE, spoken in Elizabethan 17th century England, used seven second person personal pronouns (2ppp): thou, thy-thine, thee, ye (these five now decayed) and your, you (these two extant, then and now). The last two forms serve all present day MoE 2ppp usage.

There are two reasons why students should know all seven forms. One is linguistic, the other is literary. The seven forms demonstrate:

a) linguistically, present day MoE consistency amongst all personal pronouns: first, second, and third person: singular and plural. The seven forms abet introducing

b) literarily, a speech message's messenger and addressees, i.e. different points of view (pov's), one of three relations both singular (S) and plural (P):

1st person - that pov of speaker(s)'s self "I/We (S/P) speak."

2nd person - that pov of one(s) spoken to, "You (both S & P) speak."

3rd person - that pov of one(s) spoken of, (S/He/It: They (S:P) speak(s)."

Stack one explores comparisons amongst first, second, and third person personal pronouns. Like the other two personal pronouns, the 2ppp subsumes case and number inflections.

These comparisons are the crux of this stack . The now decayed five forms plus the surviving your and you demonstrate the 2ppp comprehensive mapping (both case and number) upon the other present day MoE personal pronouns.

The stack helps students learn about the decayed forms by making connections with modern forms. The scaffolding continues through the stack's cards. Via contextual determinants the stack explores each specific decayed 2ppp form, its contextual requirements (subject/object of sentence/preposition) and compares them to students' already known 1ppp and 3ppp counterparts. A sample card is shown in Figure 1.

Figures 2 and 3 explore present day MoE 2ppp's truncations, ignoring number, i.e. both singular and plural use of your. Present day truncations also ignore case, both subjective and objective cases use you. When compared to 1ppp and 3ppp, these truncations evidence inconsistent present day MoE 2ppp usage.

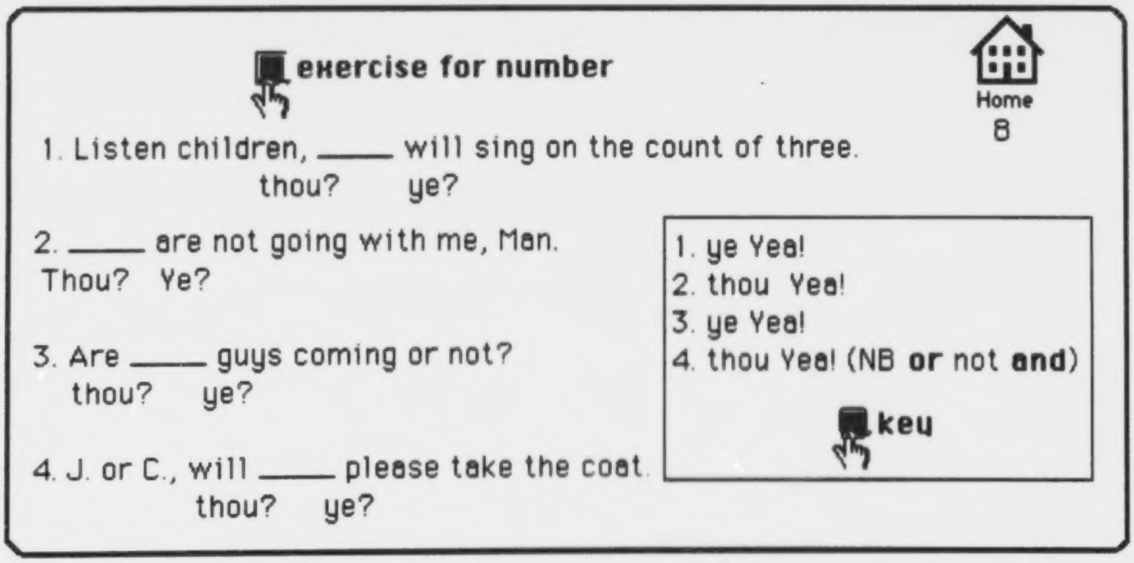
Design: Stack Two

Seventeen cards compose this second stack: the great long vowel shift. The first card addresses the target's rationale—five English vowels' shifts (Baugh, 1935; Brook 1958) and their relationship to the objectives of the course. Echoing stack one's format, this stack also employs buttons and responses, however, accordion pleats (see Figure 4 below) and sound add unique features which trace five shifted vowel sounds from Middle English (MiE) to MoE. Oddly enough the five different vowel sounds total seven and not ten. This seeming disparity complicates the shifts because both MiE and MoE share three sounds but not for the same alphabet letters. As the stack's Card 2 cites: "Which shift side (MiE or MoE) holds which vowel sounds?" The graphic pleats and acoustic features self-help students' mnemonics, remembering the two sets: MiE and MoE vowels and their respective sounds. Both stacks include self tests students can complete to test their knowledge.

Delivery: Places, Times, Copies

Students can access the stacks over the campus wide network. Since most campus Macintoshes (Mac's) network to the mainframe, the Instructional Computing Center need only load the stacks on the server. To activate any one stack, students click a stack's icon and that stack loads from the server to the student's Macintosh.

We encourage students to work in tandem or trios because of the support this approach offers them in both operating the computer and exploring the stacks' contents. Four academic buildings have computer labs, each containing 5 to 25 computers (Mac's and IBM PC's). Open seven days a week, the ICC, the library, and two dormitories can also deliver the stacks in computer labs to students. Students can also copy stacks to a floppy disk and use them on



exercise for number

Home

8

1. Listen children, ____ will sing on the count of three.
thou? ye?

2. ____ are not going with me, Man.
Thou? Ye?

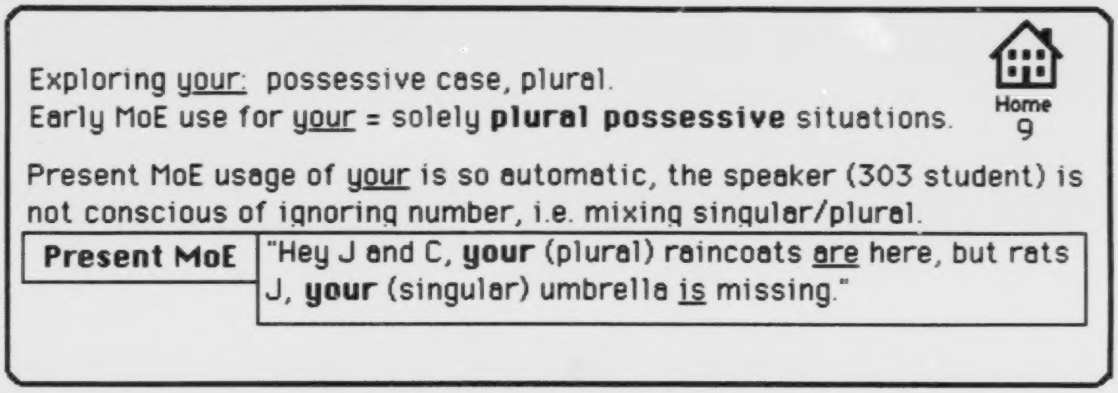
3. Are ____ guys coming or not?
thou? ye?

4. J. or C., will ____ please take the coat.
thou? ye?

1. ye Yea!
2. thou Yea!
3. ye Yea!
4. thou Yea! (NB **or** not **and**)

key

Figure 1. A Sample Card from the First HyperCard Stack.



Exploring your: possessive case, plural.
Early MoE use for your = solely **plural possessive** situations.

Present MoE usage of your is so automatic, the speaker (303 student) is not conscious of ignoring number, i.e. mixing singular/plural.

"Hey J and C, **your** (plural) raincoats are here, but rats J, **your** (singular) umbrella is missing."

Figure 2. Modern English Use of 2ppp Truncation.

home computers not connected to the campus network. If students experience difficulty grasping a stack's particular aspect, they may print out a single card and consult with the author or the course's teaching assistants about that particular topic.

Preliminary Results

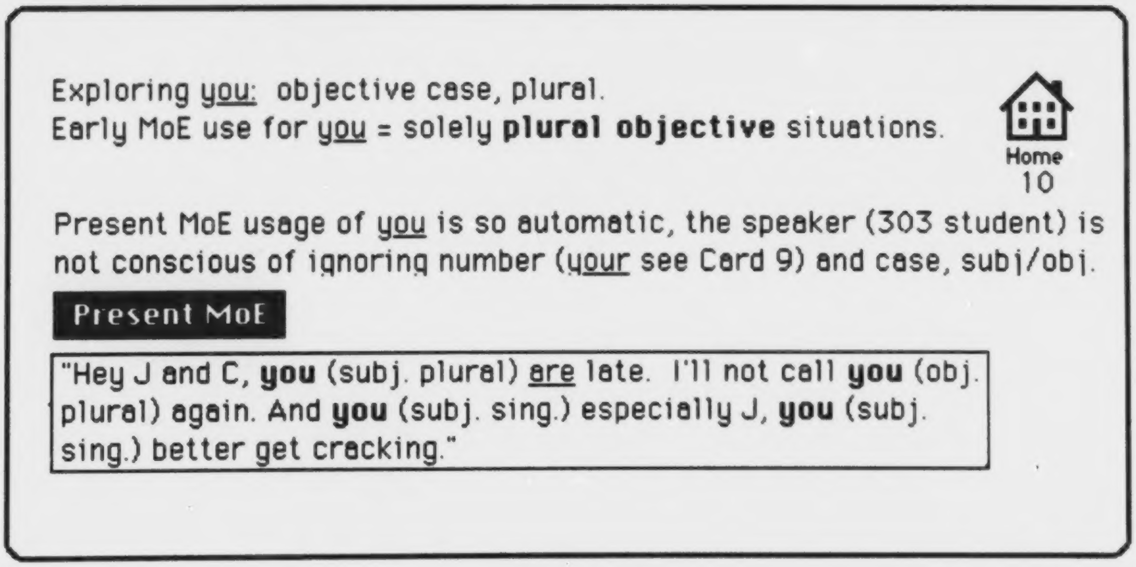
The content of the two stacks is covered on the second quiz in the course (Q2). This report collapsed data across Fall 1992 and Spring 1993 classes yielding a sample of 199 students. Students accessed/explored self helps before taking Q2. This report analyzed Q2 scores separately and compared the following data:

a) self help users vs non-users.
b) English/foreign language concentrates and other concentrates.
c) traditional and non-traditional students.

We computed t tests and a one-way analysis of variance but decided to use an analysis of co-variance (ANCOVA) as the primary statistical analysis. We used GPA as the covariate to control for differences in general scholastic aptitude.

Since data analyses yielded no significant differences for b and c above (concentrates and traditional/non-traditional students), this report will discuss the results to a) above, self help users vs non-users.

Tables 1 and 2 report significance for both unadjusted and adjusted means. Table 1., stack one content (2ppp), reports the mean (M) score for users, 10.8, was significantly different from non-users' mean score, 9.3. Table 1 also reports the ANCOVA application (the adjusted M; Adj @) partialing out the influence of GPA.

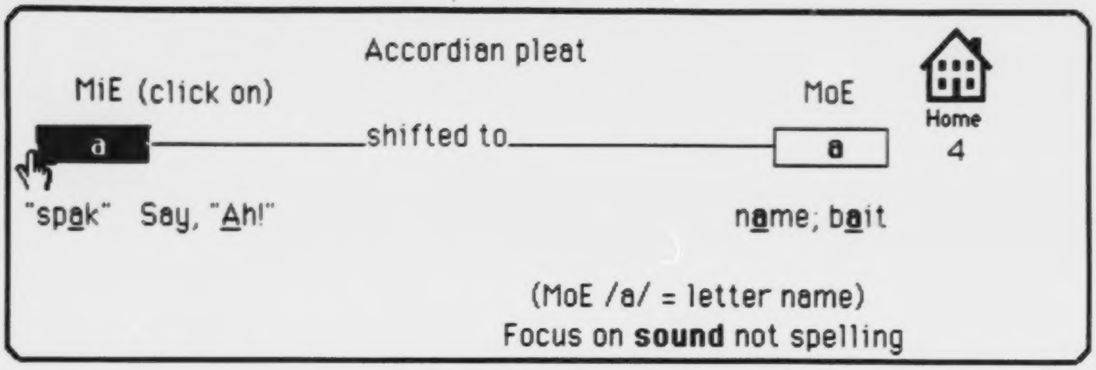


Exploring you: objective case, plural.
Early MoE use for you = solely **plural objective** situations.

Present MoE usage of you is so automatic, the speaker (303 student) is not conscious of ignoring number (your see Card 9) and case, subj/obj.

"Hey J and C, **you** (subj. plural) are late. I'll not call **you** (obj. plural) again. And **you** (subj. sing.) especially J, **you** (subj. sing.) better get cracking."

Figure 3. Use of You in MoE.



(MoE /a/ = letter name)
Focus on **sound** not spelling

Figure 4. Shifts from MiE to MoE.

Table 1
Q2 Mean Scores for Stack One

	Comparison Group	
	Users	Non-users
M	10.8	9.3
Adj@	10.7	9.4

@GPA partialled out.

Table 2., stack two content (shifted vowel sounds) reports significance again between the two compared groups. Users' Adj@, 12.2 proved significantly higher than non-users' Adj@, 11.3.

Table 2
Q2 Mean Scores for Stack Two

	Comparison Group	
	Users	Non-users
M	12.2	11.0
Adj@	12.1	11.3

@GPA partialled out.

Table 3 reports Q2's combined stacks one and two data yielding a statistically significant mean and adjusted mean.

Table 3
Q2 Mean Scores for Combined Stacks One and Two

	Comparison Group	
	Users	Non-users
M	23.3	20.3
Adj@	22.8	20.8

@GPA partialled out.

Discounting general aptitude variance (GPA partialled out) these results indicate that self help users performed significantly higher than non-users on Q2. This finding provides tentative support for HyperCard's instructional efficacy. However, future investigation requires a control/experimental design to determine the causal relationship between HyperCard use and student performance.

Those combined results foster our confidence to generate more HyperCard stacks (three partially operational currently, see below) and to encourage non-user students to use them. Anecdotal student comments support the self helps' seemingly beneficial and salutary results:

> "What! No more HyperCards?"
>
> "For the next small group exercise, can we bring our hard copies of the stacks?"
>
> "Can I have my own disk copy of the stacks? Seven students in our group intend to study together and Greg has a Mac that could access the stacks."

Twelve Projected HyperCard Stacks

With help we intend to develop over time twelve more HyperCard stacks for the course:

I. English History Components
  - Verbs: Strong, Weak, Partially Strong (1).

II. Linguistics (bold: partially operational, currently)
  - Verbs: transitive, intransitive, linking (2).
  - Objects: direct, indirect (3).
  - Complements: subject, object (4).

III. Literary Structures
  - Theme: prose fiction, poetry, drama (5).
  - Essay, thesis.
    a. logical structure (6).
    b. rhetorical structure (7).
  - Irony, three kinds: all genres (8).
  - Drama
    a. French scene (9).
    b. conflict, between/amongst characters (10).
  - Poetry, sound
    a. scansion
    b. features: alliteration, assonance, consonance (12).

VI. The Computer Science Department
  - Interns (majors) will help program presently storyboarded projected HyperCards.

We plan to design and deliver the new stacks with more elaborate sound and video capabilities.

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Implementation Issues in Using Hypermedia/ Interactive Video in Special Education

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Project ALIVE!: Acquiring Literacy through Interactive Video Education is a federally–funded project designed to assess the implementation and the impact of interactive video on the reading and writing of deaf high school and intermediate–level students. The project provides training, support, multimedia equipment, and resources to teams of two faculty from each of four programs for deaf and hard–of–hearing students.

The implementation plan for Project ALIVE! is based on Thurston's START model (n.d., cited in Bienvenue & Toth, 1992), which indicates that *S*upport, *T*ime, *A*ccess, *R*esources, and *T*raining are all necessary for the successful implementation of new innovations (including technology) into the classroom. The project also uses a Teacher Empowerment model (e.g., Glatthorn, 1992; Heller, 1993), which emphasizes extensive teacher control of the implementation process and extensive teacher involvement in decision making.

This paper presents implementation issues that have emerged during the first year of the project. A wide range of information has been collected by participants in this project – seven teachers and one media specialist – and the most important "lessons learned" are described herein.

Support

Participants report that having Project ALIVE! staff available for support via phone, electronic mail, and monthly visits is an essential component of their success with interactive technology. This technical and curricular support appears to have benefits in terms of (a) increasing implementation efficiency and effectiveness, and (b) fostering feelings that the teacher's work is valued.

Administrative and peer support are also key factors for success. For example, administrators from the schools were invited to a showcase at the end of the initial training program. This allowed administrators to understand the project more fully and to support the teachers on their return to school. Peer support (both at the local school and between schools) is being fostered through electronic mail, visits between schools, and additional training/ curriculum development activities during the school year.

Project ALIVE! also provides support in the form of monetary compensation (stipends for training and funds for curriculum development work). Such support, participants report, is important because it symbolizes that they are professionals who have substantial contributions to make.

Time

Not surprisingly, time is the number one problem identified related to the implementation of interactive technology. Originally, our plan was for teachers to be released from their classes one day a month for curriculum development and other activities. It soon became clear that such was impossible due to the amount of work needed to prepare for a substitute teacher and/or the unavailability of substitutes with experience with deaf students. Therefore, during the first semester of implementation, teachers were paid for curriculum development on one Saturday each month. In Spring, 1994, this plan was modified to permit the teachers and staff more flexibility in curriculum development. For example, some teachers continued extensive curriculum development on their own; others outlined projects and work with university students to develop materials. Other resources were devoted to activities that could benefit all in the project (e.g., creating data bases of video clips from videodiscs).

Perhaps one of the most important lessons related to time usage was the recognition by participants of different uses of the technology. During initial training, we had used what might be called a *product development* focus—where the goal was to develop a comprehensive hypermedia unit related to a particular videodisc. From this initial focus, some teachers moved quickly into using the computer as a *tool* for daily lesson support and encouraging *student uses*. Over one semester's time, all of the participants made the transition from a product development focus only to varied uses of the technology. Increased use of the technology appeared to be most closely related to the change from a product development focus to a tool use focus.

Access

During Year One of the project, the two teachers from each program have exclusive use of a computer/video workstation in their own classrooms (i.e., others in the school are not allowed to use the equipment). Although no comparative data are available, we believe that such use has allowed the teachers to integrate technology more fully than would be possible otherwise.

However, even with the current arrangement, problems in access have emerged due to distances between classrooms, difficulties in acquiring movable furniture, and use of the system by one teacher when the other has planning time. Some of these problems will be alleviated during Year Two when an additional workstation is purchased and plans for local fund–raising are initiated. In the meantime, teachers have come up with innovative strategies, including making time–sharing arrangements and requesting that Asymetrix's *Compel* (a major software tool in the project) be purchased for the school lab for student use.

Resources

Project ALIVE! uses PC–based 486 computer systems with CD–ROM drives, sound boards, video overlay boards, and frame–accurate videodisc players as multimedia workstations (video digitizing boards and optical scanners will be added during Year Two). Large–screen (32") televisions and VGA to NTSC converters are used for projection purposes. Each team also has a personal–level laser printer and a budget for curriculum materials such as videodiscs and CD–ROMs.

The decision to use high–end equipment was based on what Sheingold and Tucker (1990) call the misconceptions of power, timing, and incrementalism, which often lead educators to seek low–end solutions. High–end equipment must be tested now, despite high costs, in order for schools to be ready to take full advantage of these technologies when costs decrease.

Major problems related to resources have been of two types: (a) accessibility for deaf and hard–of–hearing students to sound–based media, and (b) identification of effective, affordable projection technology.

The accessibility issues have been the most problematic. For example, King (1993) reported that only 2% of educational videodiscs and 17% of entertainment videodiscs are captioned. Although no similar statistics are available for other interactive materials, access to information presented via digital video or audio is often restricted for deaf and hard–of–hearing students. Access problems, however, occur even when captioned materials are available. Project ALIVE! participants have been dealing with captions that appear (and disappear) inconsistently when a videodisc is accessed in an interactive manner. The problem was finally tracked down to the analog–to–digital converter used in the videodisc player. For the short term, we are switching to videodisc players that do not have analog–to–digital converters, but this means losing frame accuracy and still–frame capability with CLV–videodiscs. (Readers interested in our long–term plans regarding this problem should contact the first author.)

The search for appropriate projection technology was a challenge for Project ALIVE! Cost, lighting, and/or flicker problems made LCD panels, large–screen monitors, and low–cost VGA to NTSC converters unacceptable for our purposes. (Note: Lighting problems were especially important in that the students and teachers rely on visual means of communication—turning out the lights is simply not an option!) After much searching and evaluation, we finally selected medium–cost (~$1,200) VGA to NTSC converters and large TVs. Although still costly, this solution has the side benefit of allowing teachers and students to record their multimedia presentations on videotape. A negative consequence of the decision has been that some previous work must be redesigned because the TV does not display the top and bottom 4% of the screen (Note: the converter includes drivers that eliminate this problem, but they do not work with the video configuration we are using.)

Training

Two aspects related to training are of note: (a) selection of easy–to–use tools, and (b) recognition that extensive training must be on–going throughout the school year as well as during summer workshops.

We decided to use a multimedia presentation program (Asymetrix's *Compel*) as the basis for much of our work. We chose this over more powerful programs such as *Toolbook* and *HyperCard*, because we wanted the teachers to concentrate on instructional issues rather than scripting (some of *Toolbook*'s power was made available to teachers via templates created by the first author). This decision appears to have been a good one in that teachers were creating sophisticated hypermedia presentations with a week's training (e.g., teachers were able to create animations, hyperlinks, and media links without having to develop and debug scripts). During Spring, 1994, we will expand the basic set of tools to include *Express Author* (a front–end for *Toolbook*, developed at the Institute of Academic Technology, University of North Carolina at Chapel Hill), which will provide even greater functionality for teachers, also without having them need to learn scripting.

Initial training for the teachers and media specialist was provided in a month–long training and curriculum development workshop at Gallaudet University during Summer, 1993. A follow–up workshop (on digital video) will be provided in Summer, 1995, and the participants will conduct their own dissemination and training workshop in Summer, 1996. We originally planned to supplement the workshops primarily with just–in–time training via phone, email, and visits. Since that time, we have recognized that more extensive training sessions during the year provide important opportunities for participants to share ideas face–to–face and to ensure that everyone benefits from the just–in–time training created in response to a specific teacher's request. New software (e.g., *Express Author*) and hardware (e.g., scanners) also provide occasions for which extensive training and practice may be more effective than just–in–time training.

Summary

This paper summarizes some of the implementation issues and problems Project ALIVE! has addressed in its first year. Evaluation data concerning our implementation efforts and the impact of interactive technology on student and teacher outcomes will be forthcoming.

Acknowledgment

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James H. Barrie, Vivian H. Dalmas, Anthony D. Hornick, Leslie H. Kendall, Gretchen Miller–Selvage, Rosemary A. Stifter, Charles C. Welsh–Charrier, and Wilda H. Whitley (Affiliations and contact information for these individuals can be found at the end of the King et al. and Noretsky et al. articles in this volume.)

Individuals seeking general information about Project ALIVE! should use one of the following avenues of contact: Voice Phone: 202–651–5545, TDD (Telecommunications Device for the Deaf) Phone: 202–651–5685, FAX: 202–651–5710, Postal Service: Project ALIVE!, Fowler Hall Room 404, Gallaudet University, 800 Florida Avenue, NE, Washington, DC 20002–3695, Email: cmking@gallua.BITNET or cmking@gallua.gallaudet.edu.

Interactive Video, Hypermedia, and Deaf Students: Literacy Applications

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Project ALIVE!: Acquiring Literacy through Interactive Video Education is a federally–funded project designed to assess the implementation and the impact of interactive video on the reading and writing of deaf high school and intermediate–level students. The project provides training, support, multimedia equipment, and resources to teams of two faculty from each of four programs for deaf and hard–of–hearing students.

The basic goal of the project is to provide teachers and students with tools for enriching instruction through visual means. The project's toolbox includes: (a) multimedia programs (Asymetrix's *Compel* and *Toolbook*), (b) electronic resources (e.g., Microsoft's *Bookshelf* and *Software Toolworks Multimedia Encyclopedia*), (c) basic productivity tools (e.g., Window's Accessories and other programs such as Microsoft *Word*), (d) clip art and scanned images libraries, and (e) captioned videodiscs.

In this paper, the applications that seven teachers, a media specialist, and their students have developed give readers a flavor of the project through description and sample screen shots. One example from each participant is provided and these are a but a small representation of the strategies the group as a whole developed. The examples are organized as follows: (a) visually–supported instructional strategies, (b) visually–supported vocabulary activities, (c) uses of graphic organizers, (d) uses of hypermedia resources, (e) and student uses of hypermedia and interactive video.

(Note: This paper addresses literacy applications. Noretsky et al., in this volume, address science and social studies applications. King and Larkins, in this volume, address issues related to the process of implementing interactive technology in classrooms for deaf and hard–of–hearing students.)

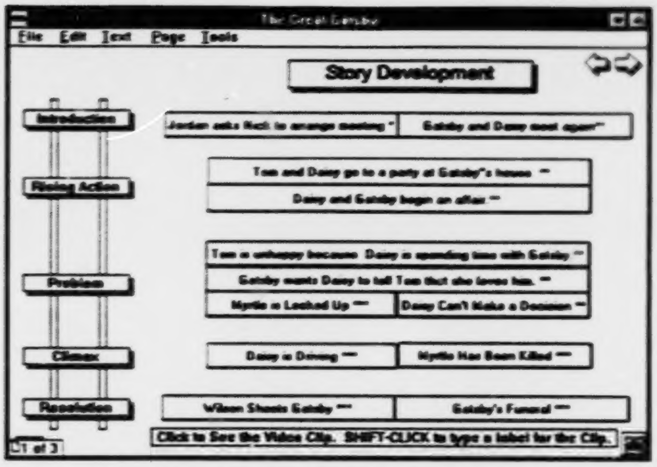
Visually–Supported Instructional Strategies

Each of the teachers in the project selected a captioned movie on videodisc to use as the basis for their first effort with interactive instruction. Examples of how teachers used those materials for English classes are provided.

Story Structure

Vivian Dalmas used the movie, *The Great Gatsby*, as the basis for her instructional unit. She identified highlights of the movie and then created an instructional screen where she and her students could watch the video clips and create descriptive labels for each event. An example of a completed screen is shown in Figure 1. (Note: clicking on one of the buttons plays that clip full–screen. The number of asterisks after the description indicates the side of the videodisc on which the clip can be found.)

Leslie Kendall used the movie, *The Last of the Mohicans*, as the basis for her instructional unit. She used the instructional screen shown in Figure 2 to help students develop better prediction skills. The plot diagram shows the basic structure of the story. Students completed brief writing exercises (to evaluate their previous prediction and


The Great Gatsby
File Edit Text Page Tools
Story Development
Introduction
Rising Action
Problem
Climax
Resolution
Jordan asks Nick to arrange meeting
Gatsby and Daisy meet again
Tom and Daisy go to a party at Gatsby's house
Daisy and Gatsby begin an affair
Tom is unhappy because Daisy is spending time with Gatsby
Gatsby wants Daisy to tell Tom that she loves him.
Myrtle is Locked Up
Daisy Can't Make a Decision
Daisy is Driving
Myrtle Has Been Killed
Wilson Shoots Gatsby
Gatsby's Funeral
1 of 3

Click to See the Video Clip. SHIFT-CLICK to type a label for the Clip.

Figure 1. Story Structure for *The Great Gatsby*.

make a new prediction) after each video clip.

Character Development

All of the participants created instructional screens where students could see pictures and video clips of the various characters in the movies. They also developed semantic webs and other graphic organizers (see below) to develop rich descriptions and comparisons of the characters.

Movie–Book Comparisons

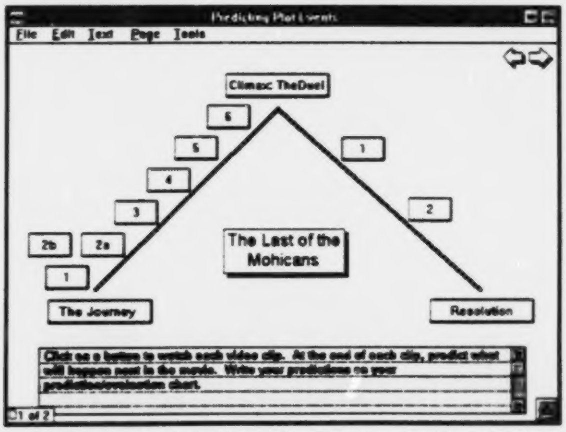
Cindy King used the movie, *Lord of the Flies*, as a model for teacher units. She identified portions of the movie that were different from the book and then created an instructional screen where students could compare the movie and the book text. The instructional screen, shown in Figure 3, allows students to view the video, a portion of the book text, a movie review, and a book review. Students then select the *Write* program through the Tools menu item and write a summary of the movie–book differences. (Both the writing program and the instructional screen can be visible at the same time or students may switch back and forth between them).

Visually-Supported Vocabulary Activities

Gretchen Miller–Selvage used the movie, *Bill and Ted's Excellent Adventure*, as the basis for her instructional unit. Wanting her students to be aware of the slang used by hearing teenagers, she developed an instructional screen (see Figure 4) whereby she and her students could view contextualized video clips where such slang was being used. The ClipNote on the bottom left side of the screen, then, could be used for the teacher to provide more information or for students to type in their own interpretations of the phrases.

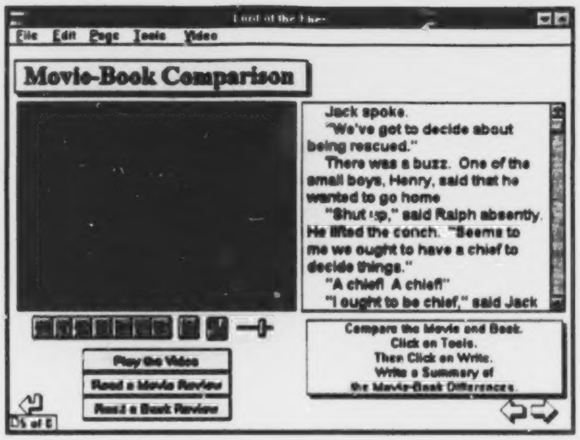
Uses of Graphic Organizers

All of the participants in the project were excited by the ability to create professional–looking graphic organizers for their instructional units. The example in Figure 5 was created by Chic Welsh–Charrier in a comparative study he and his students did for the novels *Maniac Magee* and


Predicting Plot Events
File Edit Text Page Tools
Climax: TheDuel
6
5
4
3
2b
2a
1
1
2
The Last of the Mohicans
The Journey
Resolution
1 of 2

Click on a button to watch each video clip. At the end of each clip, predict what will happen next in the movie. Write your predictions on your prediction/evaluation chart.

Figure 2. Predicting Activity for *The Last of the Mohicans*.


Lord of the Flies
File Edit Page Tools Video
Movie-Book Comparison
Play the Video
Read a Movie Review
Read a Book Review
5 of 6

Jack spoke.
"We've got to decide about being rescued."
There was a buzz. One of the small boys, Henry, said that he wanted to go home
"Shut up," said Ralph absently. He lifted the conch. "Seems to me we ought to have a chief to decide things."
"A chief! A chief!"
"I ought to be chief," said Jack

Compare the Movie and Book.
Click on Tools.
Then Click on Write.
Write a Summary of
the Movie-Book Differences.

Figure 3. Movie-Book Comparison Activity for *Lord of the Flies*.

Slake's Limbo. Venn diagrams, as in Figure 5, and semantic webs (see Noretsky et al., in this volume) quickly became a favorite means for teachers and their students to show relationship among concepts.

Uses of Hypermedia Resources

Participants in the project were given a *Compel* presentation that contained hypermedia buttons for linking to programs such as Microsoft's *Bookshelf*, the *Software Toolworks Multimedia Encyclopedia*, and various other hypermedia programs. Also included were buttons for linking to the basic Windows accessories and other Windows and/or DOS programs. The teachers have found some exciting instructional uses for these tools. For example, several teachers have pasted the encyclopedia button on the background of their presentations so that the encyclopedia is always available. At first, some of us wished we could develop buttons that navigated to the exact item in the encyclopedia we wanted to use. Now, we see this as an important instructional feature in that students are repeatedly exposed to the process of finding items they want in resource materials. The English teachers are also using the *Write* and *Paint* accessories in Windows, as well as more powerful word processing programs, for enriching their instruction. *Compel* is sometimes used as a source (i.e., menuing system) from which various documents and graphics are accessed in an interactive fashion.

Student Uses of Hypermedia and Interactive Video

The teachers in this project have been very creative in involving students in the development and use of hypermedia. Sometimes, teachers create cooperative learning groups and have students use the computer on a rotating basis. Other times, they have students come up and use the computer during whole–class instruction activities. Several of the teachers have begun having students create their own multimedia presentations. Not surprisingly, students appear to enjoy being active creators and organizers of information. Students and teachers alike are looking forward to more student–generated projects that will be

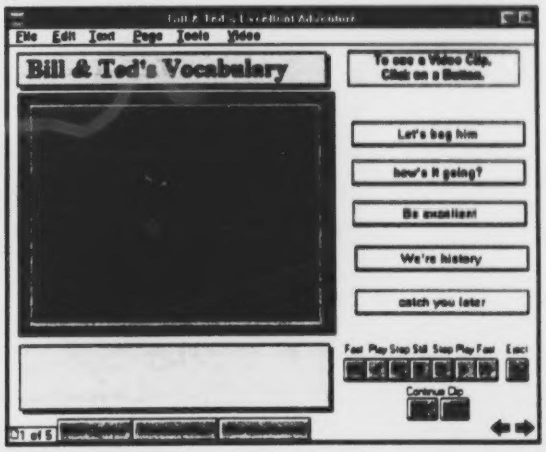

Bill & Ted's Excellent Adventure
File Edit Text Page Tools Video
Bill & Ted's Vocabulary
To see a Video Clip,
Click on a Button.
Let's bag him
how's it going?
Be excellent
We're history
catch you later
Fast Play Step Still Step Play Fast Eject
Continue Clip
1 of 5

Figure 4. Vocabulary Exercize for *Bill and Ted's Excellent Adventure*.

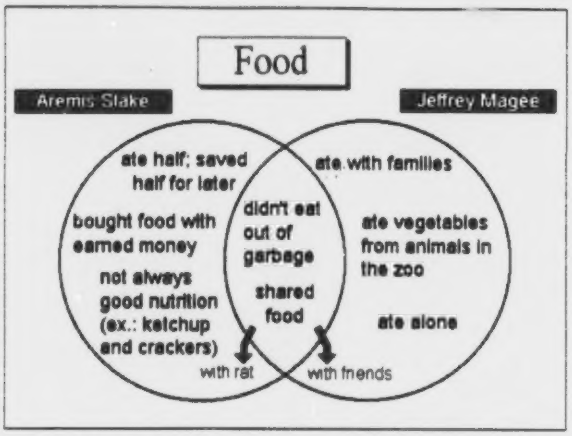

Food
Aremis Slake
Jeffrey Magee
ate half; saved half for later
bought food with earned money
not always good nutrition (ex.: ketchup and crackers)
didn't eat out of garbage
shared food
with rat
with friends
ate with families
ate vegetables from animals in the zoo
ate alone

Figure 5. Graphic Organizer for Comparison of Two Novels.

possible with increased availability of computers and projection technology and with the new *Video ClipMakers* available in *Express Author* (see King & Larkins, in this volume).

Summary

This paper provides examples of some of the instructional strategies, goals, and instructional screens teachers have developed for teaching English to deaf and hard–of–hearing students. These teachers and their students present and discuss new and old information in a contextualized, visual manner that is supported by a rich set of interactive media and authoring tools.

Acknowledgments

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[Note: Order of authorship does not reflect amount of contribution to this work. Project ALIVE! staff were given first and last authorship on the paper, and the teachers were given authorship in alphabetical order.]

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HyperCard Shellware: Templates for the Classroom

Michael Land
Midwestern State University

Since *HyperCard* was originally shipped in 1988, thousands of stacks have been written. Most of them, however, have either been utilities, tutorials, or single-purpose stacks. Very few of them have been templates or shells that can be easily tailored for a variety of grade levels and/or in a variety of content areas to reflect the needs of the classroom teacher and his or her students.

Although *HyperCard* and other hypermedia products were supposed to make it easier for classroom teachers to write their own software, that has not been the case. Those who have kept in touch with the public school classroom know that teachers do not have time to write their own software, even if programming with *HyperCard* were easier than previous programming environments. *HyperCard* is easy enough to learn, however, so that many people have learned how to construct stacks. The primary purpose of this paper is to describe some *HyperCard* instructional template stacks. Another goal is to encourage other stack creators to write educational stack templates and to share them with teachers and teacher educators.

A Stack Template

A stack template or shell is one that contains all of the programming and instructions to "run" a stack but can easily be used with different content. By simply changing the name of the Haunted House stack and the events and names of the rooms, any teacher (or student) can change this stack into one about adventures at a zoo or any other place.

One of the annoying problems with many stack templates, or any template for that matter, is to have some method of keeping the original while using a copy. While some programs, *PageMaker* for example, prevent you from saving back to the template, that is not true in *HyperCard*. Users can make a copy of a stack from inside the stack or from the Finder, but must remember to do so each time. Ideally, the best solution would be to prepare the stack so that the user would not have to remember to make a copy each time she or he started a new variation of the template. One solution to this dilemma is to make the stack a stationery file. Assuming you are using System 7 or above, the steps are:

- From the desktop, click once on the stack template icon.
- Use command-I (or File/Get Info) to display the Info dialog box.
- Click the Stationery pad button so there is an x to the left.
- Close the dialog box.

When you open the stack, you will be prompted to enter a name for the new stack. It is important to choose a name other than the name of the template.

Two Handlers

If you are a *HyperCard* stack template author, another way you can avoid ruining your template stack is to use handlers. Handlers allow the user to make a working copy of the template without having to remember to work with a copy of the stack rather than use the master copy. Two examples of handlers are:

```
on setUp
    if the short name of this stack contains
   "Mstr Test"
   then
     createStack
   end if
end setUp

on createStack
   ask file "What name do you want to use for
    your quiz stack?"
   put it into newStack
   if the result is "Cancel"
   then
     answer "Now exiting this option."
     exit createStack
   else
     if "Mstr Quiz" is not in newStack
     then
       save this stack as newStack
       go to stack newStack
     else
       answer "Try a name other than Mstr
    Quiz."
       createStack
     end if
   end if
end createStack
```

The Haunted House is located on one of the activities disks in Turner, S., & Land, M. L. (1994). *HyperCard: A tool for learning*, Belmont, CA: Wadsworth Publishing Co.

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HyperCourseware for Assisting Teachers in the Interactive Electronic Classroom

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University of Maryland

An electronic classroom is a special room outfitted with computer workstations for each student and for the teacher. The computers serve multiple functions. They may be used for taking notes, for taking exams, for participating in class discussion, for presenting lecture and textbook material, as scratch pads, and sometimes as computers. All of the computers in the classroom are networked and tied into a shared file server. The file server allows information to be exchanged between the students and the teacher. In addition, the electronic classroom will have high resolution video projectors that serve as electronic blackboards to display either what is on any of the computer monitors or multimedia presentations. Such a classroom offers tremendous potential for interactive, multimedia instruction; but it also requires an unprecedented need for training and support of teachers to develop materials and to use this complex technology in class.

This paper describes a specific electronic classroom and the software being developed to assist teachers in managing all aspects of the educational process. The goal of the project is to house educational materials in an electronic form while at the same time minimizing the amount of technological knowledge needed on the part of the teacher. Thus, the environment should allow teachers to teach rather than requiring them to be masters of a new technology.

The Electronic Teaching Theater

Figure 1 shows the schematic of a prototype electronic classroom at the University of Maryland called the "AT&T Teaching Theater." The room is fully outfitted as an experimental testbed for new educational technologies. It contains 20 workstations for the students with monitors that are recessed into the desks to allow a good line of sight. All of the computers are located in an adjacent room to reduce noise. The classroom has two 4 x 6 foot high resolution rear projection screens in the front. Video switching provides a seamless transition of input from the instructor's monitor, a VCR, a video disc player, a slide projector, and a video overhead projector. All switching and control of audio/visual equipment is through a touch screen at the instructor's desk. All of the signals to and from the student workstations are routed through a switch that allows the instructor to display what is on any student monitor on the instructor's monitor and in turn on the large displays. Furthermore, any selected screen (student or instructor) can be displayed on the student monitors. The instructor can also intercept the keyboard and mouse to take control of a student workstation.

The electronic classroom is not meant to be a glorified computer lab in which one learns about computers. The technology of the electronic classroom provides a unique potential for interactive and collaborative learning of any subject. The question is whether one has to become a computer expert in order to use it. Even though the room was designed with simplicity and ease of use in mind, it is nevertheless intimidating to the potential teacher.

The goal of the current project has been to create an electronic teaching environment that is easy to use and requires little or no training beyond basic teacher education.

The environment must support the traditional activities of instruction and learning and also provide new capabilities for communication, feedback, media richness, exploration, and collaborative work. The approach taken in this project has been to develop a graphical user interface that supports: (a) course development; (b) lecture presentation; (c) class discussion and interaction; (d) evaluation and record keeping; and most essential (e) an environment for exploration, discovery, and group collaboration.

HyperCourseware

The two major problems that have hampered the introduction of computer technology in the classroom have been the lack of integration and connectivity between the myriad of programs available and the absence of unifying metaphors to help structure the implementation. The lack of a consistent, unified system has required teachers to learn esoteric commands, conflicting modes of operation, and unreasonable steps link one program to another. Without an easy to use, integrated environment, the obstacles to using technology in education are insurmountable for most teachers and require extensive training for others.

To assist teachers in transitioning to educational technology, Norman (1990) proposed that the traditional objects of classroom instruction should be matched in the electronic classroom. Objects such as the course syllabus, the lecture notes, the class roll, etc. should be instantiated in graphic form in the electronic classroom. Furthermore, the concept of hypermedia should be used to link the objects together and allow both teachers and students to navigate from the syllabus to lecture notes to the textbook and so on. This approach has been implemented in the form of "HyperCourseware" in the electronic classroom. *HyperCourseware* is a system of interlocking programs and files that serves as an electronic infrastructure for classroom and distance learning. It serves to create on a computer network what had previously been in notebooks, on the blackboard, and in textbooks. *HyperCourseware* is currently in prototype form and is implemented using *Spinnaker Plus*™, a stackware application that runs in either the Macintosh™, Windows™, or OS/2™ operating systems.

A major function of *HyperCourseware* is to off-load much of class management as possible from teacher onto the system. As implemented in the in AT&T Teaching Theater, both the teacher and the students sign onto a workstation with their account name and password. The system records the attendance of the students and then presents the "home" screen shown in Figure 2. At this point, the student can add a partner to the left or right. The home screen displays daily announcements and serves as the central access to the *HyperCourseware* icons shown

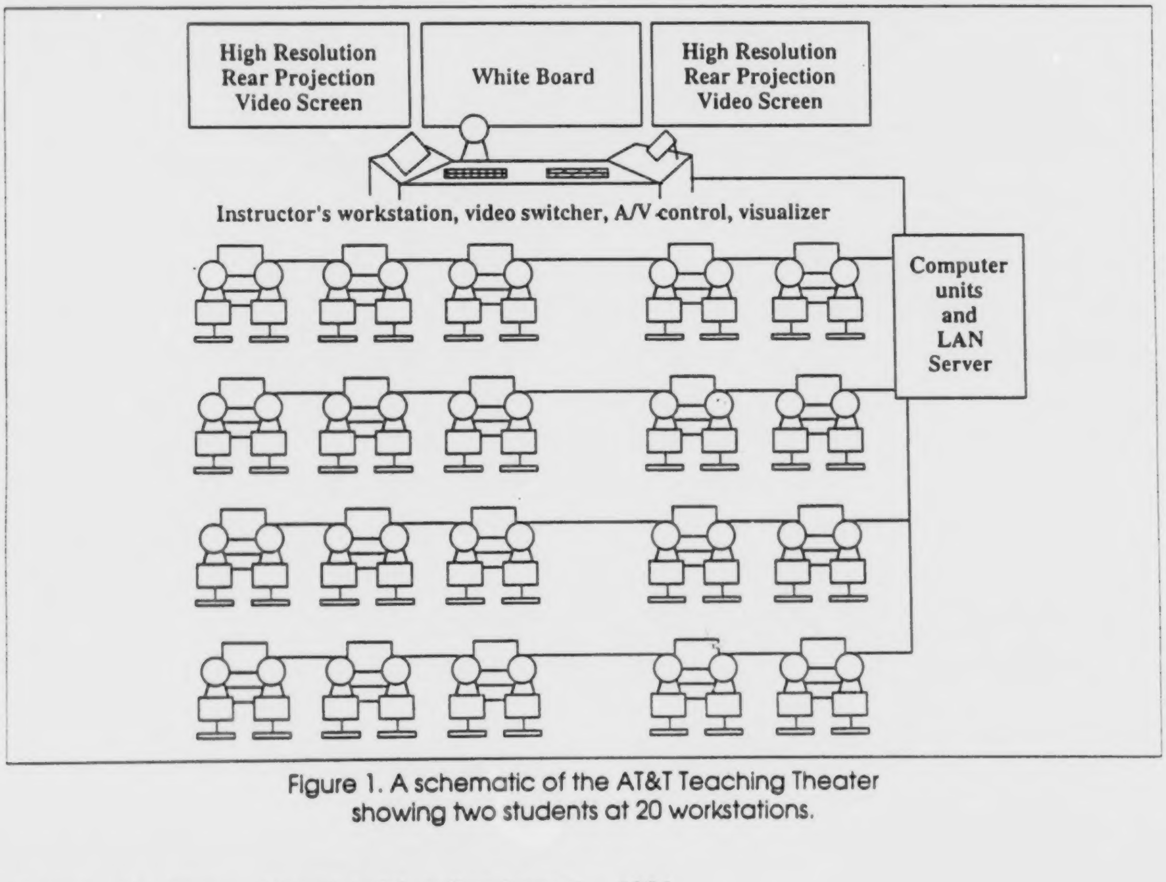

High Resolution Rear Projection Video Screen
White Board
High Resolution Rear Projection Video Screen
Instructor's workstation, video switcher, A/V control, visualizer
Computer units and LAN Server

Figure 1. A schematic of the AT&T Teaching Theater showing two students at 20 workstations.

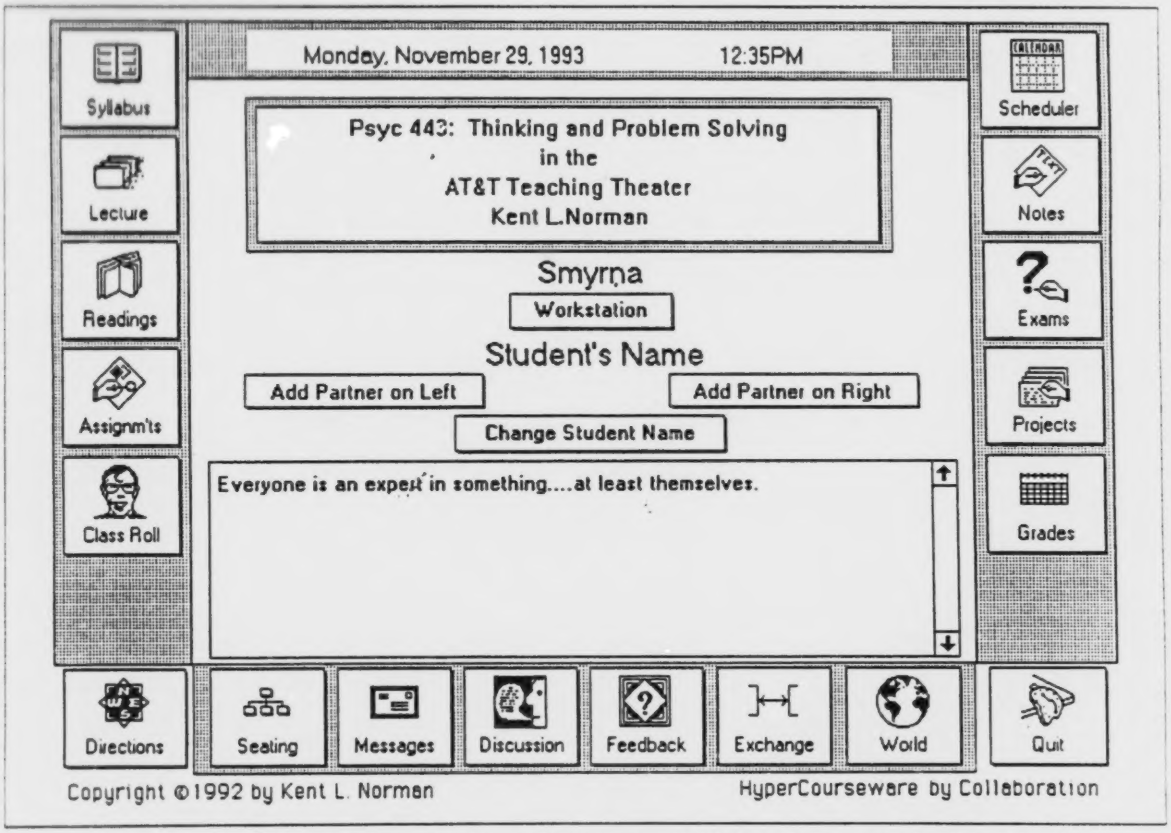
around the perimeter of the screen. Icons on the left represent course materials; icons on the right represent the products or output of the course; and icons at the bottom represent classroom tools.

Selecting any one of the icons opens up the corresponding *HyperCourseware* module. For example, Syllabus Icon opens up a listing of topics and dates. The teacher can change syllabus at any time and it is automatically disseminated to the students. From the syllabus screen students have access to all of the lecture notes for any particular day, the readings assigned that day, and the written assignments. The lecture notes screen displays an index of topics to be covered. Selecting one of the topics or paging forward accesses the graphic displays for the lecture. For example, Figure 3, shows material covered in statistics on frequency histograms. Many of these screens are interactive or use animation to illustrate a concept. For example, in a statistics course there are displays that show coins flipping to generate an observed binomial distribution. In a course on cognitive psychology, screens are used to illustrate the three box model of short term memory. The lecture modules may be previously published course material or they may be created by the teacher using an easy to use authoring system which generates new screens from a set of templates.

HyperCourseware provides an easy to use navigational system to view material. In a typical class, as the teacher guides discussion or presents a lecture, students follow along from screen to screen in sync with the instructor. However, if students fall behind or get lost, they can select the Lecture Icon from the home screen or a pointing tool on the navigational ribbon at the top of most screens. This tool finds the screen that the teacher is viewing and jumps directly to it.

The Readings and Assignments Icons back on the home screen go directly to on-line readings and assignments or to instructions about them. The assignments module helps the teacher keep track of assignments and their due date. In addition, it keeps the students constantly posted regarding assignments and relieves the teacher of mundane administrative tasks. The assignments modules provides a workspace for entering written material and submitting it to the teacher. The submission is copied to a file for the teacher to grade; it is then sent back to the student; and the grade is recorded on the grade list.

Next, the Class Roll Icon shows a list of all of the students and provides access to information about each student and a picture of each student. Students may enter their own autobiographical sketch. Pictures can be taken



Monday, November 29, 1993 12:35PM

Psyc 443: Thinking and Problem Solving
in the
AT&T Teaching Theater
Kent L.Norman

Smyrna

Student's Name

Everyone is an expert in something....at least themselves.

Copyright ©1992 by Kent L. Norman

HyperCourseware by Collaboration

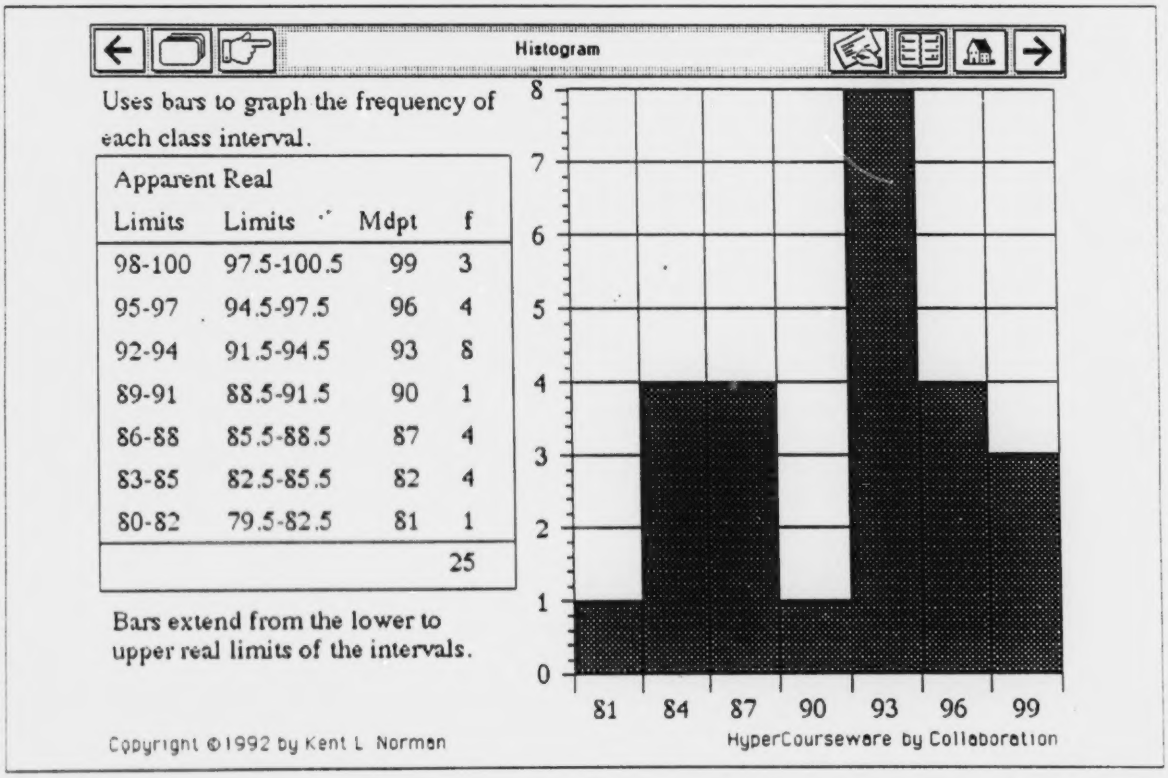
Figure 2. The "Home" screen in *HyperCourseware* which acts as a navigational hub to access other modules.

and entered using a digitizing camera. The class roll provides a facility for the students and the teacher to get to know more about each other.

Classroom interaction tools are at the bottom of the home screen. The Directions Icon provides context dependent help for both teachers and students on how to use the home screen. The Seating Icon shows a class seating chart with the names of all students at their locations from the teacher's perspective. Another seating chart from the student's perspective is available on their screens. *HyperCourseware* records the location of each student when they sign on and takes attendance. The Message Icon accesses a simple electronic mail system between the students and the teacher. The teacher can send messages to any or all of the students and the students can send messages to the teacher.

The Discussion Icon provides a number of facilities for an on-line form of discussion. For example, the teacher can post a topic or question and the students write their comments. All of the collective comments appear for all students to see. Another form of discussion is a continuous listing of all comments as they are submitted. The Feedback Icon allows the student to enter questions to the teacher or to provide anonymous feedback about the course. The Exchange Icon accesses an easy to use tool to swap files between students, to handout files to students, and in general to follow any model of file exchange among the students and the teacher. The World Icon provides access to other programs outside of *Spinnaker Plus*™ (e.g., word processors, graphics packages, statistics, programs) that reside on the computer system. Finally, the Quit Icon logs the student out of the system and records information about the session.

Along the right-hand side of the home screen are icons for the student generated products of instruction. The Scheduler Icon provides a tool for planning and recording one's study of material and completion of assignments. The Notes Icon allows students to record and view their own notes or notes taken as a group by the class. The Exams Icon is used to start exams and quizzes when they were scheduled or to view exams or quizzes after they have been graded. The Projects Icon provides a collaborative work space for group projects. For example, if two students are working on a project together, the projects tool allows both students to access the same file. Finally, the Grades Icon allows the students to see their current grades on exams and assignments.


Histogram
8
7
6
5
4
3
2
1
0
81
84
87
90
93
96
99
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HyperCourseware by Collaboration

Uses bars to graph the frequency of each class interval.

Apparent Limits	Real Limits	Mdpt	f
98-100	97.5-100.5	99	3
95-97	94.5-97.5	96	4
92-94	91.5-94.5	93	8
89-91	88.5-91.5	90	1
86-88	85.5-88.5	87	4
83-85	82.5-85.5	82	4
80-82	79.5-82.5	81	1
			25

Bars extend from the lower to upper real limits of the intervals.

Figure 3. An example of a lecture screen used in a statistics course. The navigational ribbon at the top provides access to the previous screen, the index, the teacher's current screen, student notes, the syllabus, the home screen, and the next screen.

Positive Benefits

HyperCourseware provides three features that are essential to both its ease of use and educational benefit: (a) hypermedia links between course materials, (b) integration of parts, and (c) classroom interactivity.

Hypermedia links can provide easy to use and easy to follow paths through the material that reduce the need for teacher education. Simple navigational methods of selecting icons to access modules, arrows to page through the materials, and indexes to access specific screens require little or no learning if well designed (Norman, 1991). Moreover, *HyperCourseware* provides a meaningful structure for navigation between modules. The syllabus provides the overall structure to the course materials; and within a lecture module the index provides an order to the screens. Rather than dealing with many unrelated pieces of software, the course structure allows the students to descend into the lecture material from the syllabus and from the lecture topics into the lecture details. Readings, assignments, and exams are ordered and linked in a similar way.

HyperCourseware integrates all aspects of classroom education together in one seamless, integrated package. Rather than jumping from one application to another or one window to another, cutting and pasting information, *HyperCourseware* links lecture materials, readings, students notes, class rolls, exams, grades, etc. so that both students and teachers can navigate through all of the materials from one part to another and so that information generated in one part (e.g., grade on an exam) can be used in another (e.g., computation of final grade).

Finally, *HyperCourseware* exploits the interactive nature of hypermedia and the collaborative support of networks without burdening the teacher with having to manage networks, files, and directories. Simulations and animation can used to illustrate models and processes such as binomial sampling distributions in statistics and feedback models in cognitive psychology. In class discussions, ideas, or comments generated simultaneously by individual students can be collected, aggregated, and disseminated to the class. Students working on projects as a team access common modules and contribute different parts to the final product.

Implications for Teacher Education

An electronic classroom fully outfitted with computers, software, multimedia drivers, and network access is an extremely complex environment for education. However, with the right design it can not only be an extremely powerful medium for education, it can also be very easy to use. The challenge is to design a powerful, interactive educational environment in which it is actually easier to teach than it is in the traditional classroom. *HyperCourseware* is a working prototype with this goal in mind.

Both informal and formal evaluations have been conducted in the AT&T Teaching Theater and on *HyperCourseware* which have supported their ease of use, student and teacher satisfaction with the system, and the educational benefits of the electronic environment (Norman, 1992). Student evaluations of *HyperCourseware* have been quite positive relative to the traditional classroom despite a number of early software and hardware problems (Norman & Lindwarm, 1993).

The implication of integrated educational environments such as *HyperCourseware* is that they do not require educators to learn cryptic computer operating systems and a myriad of application programs. Rather the teacher is able to concentrate on teaching the material and on guiding classroom interaction. Finally, *HyperCourseware* attempts to leverage off of what teachers are already familiar with; namely, lesson plans, class rolls, seating charts, etc. and add new power and functionality to increase media richness and interactivity. It is consequently recommended that teachers continue their study of course materials and methods of instruction but should not necessarily invest heavily in computer training. Instead educational institutions should invest in easy to use, integrated educational environments that support and enrich the teaching process.

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Requests for reprints or additional information about HyperCourseware *and its availability should be addressed to Kent L. Norman, Department of Psychology, University of Maryland, College Park, MD 20742. The author wishes to thank the staff of the AT&T Teaching Theater for their technical support.*

The Development and Evaluation of a Multimedia Model for Teaching Social History

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> *Students need to learn to criticize and erode the cultural constructions of difference that stratify people into unequal groups. To do this they need a rich understanding of what it means to be the other, a sense not only of the pleasures of knowing another's life but also of the pain of discrimination. (David B. Tyack, 1993, p. 29)*

Social history examines past events from the perspectives of common people rather than that of world leaders, presidents, or kings. The situations that effect people in their everyday lives such as finding a job, moving to a new home, or finding a spouse are as important as devastating wars, technological advancements, or great discoveries. A focus of social history is to help those in the present to understand better the lives of "ordinary" people of the past and their individual everyday struggles. In assisting in the preparation of teachers social history can provide a common understanding to which students of all ages can relate.

The purpose of this paper is to demonstrate a multimedia model for teaching social history. The model was first developed in 1991 for use in a social foundations course in an undergraduate teacher education program at Hunter College. Social foundations provides a little of the history, philosophy, and sociology of education. An appreciation and understanding of social groups and their struggles and conflicts are common elements of such a course. Future teachers need to be prepared to understand the nature of social groups if they are to be successful in touching the lives of the next generations of children, most of whom will represent a mosaic of backgrounds and cultures. While presently this may be perceived as more important in America's larger cities that have experienced wave upon wave of immigration, demographers predict that in the not too distant future, all parts of our country will be far more diverse than they are today.

Background

In 1990, the author and his colleagues at Hunter College received a grant from IBM and the City University of New York Office of Academic Computing to repurpose a highly acclaimed videotape entitled, *Five Points*, that was produced by the American Social History Project as part of its series "Who Built America?" *Five Points* examines the lives of recent Irish Catholic immigrants in New York City in the 1850s and culminates in a riot that occurred in 1857 in which twelve people were killed and hundreds injured. The material easily relates to current social issues that exist in many American cities that have attracted large immigrant populations. The multimedia version used most of the original videotape material and added additional graphics, text, and statistical data on the period. The model for developing the multimedia version was based on discovery learning techniques and strategies. In addition to courses in teacher education, the program has been used successfully in other subject areas such as sociology, basic writing, communications and human services.

A second program entitled, *Heaven Will Protect the*

Working Girl, has just been completed. *Heaven*... looks at the lives of immigrant Jewish and Italian teenage girls working in New York City's garment industry in the early 1900s. Their story culminates in a decision to strike against the intolerable working conditions that existed at the time in what came to be known as the "Uprising of the 30,000" during which more than seven hundred women were arrested. Their conflict while ostensibly one of management and labor also involved serious cultural and family differences that pitted parents against children and challenged societal expectations regarding the behavior of women. The design, development, and evaluation of the model used for both of these programs may prove helpful to others contemplating developing similar materials.

The Model

The model utilizes discovery learning, curiosity to build interest, and inductive reasoning concepts to take a single, obscure historical event and expand it into an exploration of broader social issues. It makes extensive use of the interactive capabilities of a modern authoring language and requires students to be involved in the learning activity. The three major learning objectives of the model are:

1. to motivate students to be sensitive to social issues such as poverty, group conflict, and cultural differences;
2. to inform students of the historical nature of these issues;
3. to involve students in an activity wherein they can explore and develop their own ideas and opinions of these issues.

The programming model is organized into five main components:

1. An introduction designed to begin the process of building curiosity and involvement;
2. Video clips designed to take advantage of video, graphics, sound, and music to further student interest;
3. An electronic archive room designed to provide students with text, statistical data and other material meant to be read;
4. An open-ended writing assignment;
5. A conclusion that relates the event to the present.

While some elements of the model such as curiosity building, active learning, and the value of writing as a reflective learning tool are taken from standard texts on instructional design such as Dick and Carey (1985), Gagne (1985), Hannafin and Peck (1988), and Kemp and Smellie (1989), other elements particularly as integrated and applied to the multimedia presentation and the social history content are unique.

The introduction begins the process of building curiosity by presenting several brief "tease clips" about the event. These clips perform a "coming attractions" function that give the students little tidbits of images and dialogue that hopefully will motivate them to want to know more. The introduction also presents the students with an open-ended writing assignment in which opinions or positions taken must be substantiated based on the material that exists within the program.

The second component (video clips) is designed to utilize the powers of sight and sound to continue the process of building student interest in the event. The clips are not simply narrative descriptions but are designed to present differing points of view about the event thereby confronting the student with choices for further investigation.

While sights, sound, and motion might initially stimulate student interest, once the novelty wears off so might the interest (Hannafin and Peck, 1988; Lockard, 1992). The electronic archive room provides an array of text, notes, maps, statistical carts, and source documents that can be used to substantiate the commentary in the video clips. Most of this material is also meant to be read and examined more slowly.

The open-ended writing assignment is used as an active learning tool that stands at the center of the program and requires the students to gather facts, compare conflicting accounts, and draw conclusions about complex social phenomena. Writing is not used simply to assess students but to force them to reflect consciously on the information provided in the program as well as on their own opinions.

After completing the writing assignment, the program concludes by posing several provocative questions that relate the historical event to modern times. These are excellent for initiating class or large group discussions and enable the students to understand the general nature of the social issues they have just explored. For a more extensive treatment of the details of the model and its relationship to instructional design concepts, readers may wish to refer to Picciano (1993).

Evaluation

In Spring 1993, four faculty members and seventy-two students at LaGuardia Community College participated in an evaluation of the first program (*The Five Points*...) to incorporate the model. The evaluation was funded by the City University of New York Office of Academic Computing. The evaluation utilized observations, interviews, videotaping, and other qualitative research techniques to study closely how faculty and students used the program. The purpose of this evaluation was to aid the developers of the program to gain insights as to aspects of the model that worked or did not work as planned and why.

As part of this evaluation, the faculty participants were given an orientation and training session on using the interactive video program. It is important to mention that the four faculty participants never had made any extensive use of computer technology in their classes prior to this evaluation with the exception of one instructor who regularly used word processing in teaching basic writing. After the orientation, the faculty were then asked to develop lesson plans that included statements of their teaching/learning objectives and descriptions of how the program would be used to achieve them. During actual utilization of the program in their classes, an independent evaluator observed teacher and student interactions. At the end of the semester, the faculty were interviewed and given a questionnaire assessing the program and its effectiveness in helping them achieve their objectives. Their responses were compared to those of the outside evaluator. Students were also interviewed within one week of using the program. The nature and volume of the qualitative data collected makes it impossible to report on all aspects of the evaluation here. A representative sample of the findings and comments follows.

All of the faculty participants indicated that the program was effective in helping them achieve their objectives. Comments included:

> *It is fulfilling for me to see students engaged, challenging one and another, excited about learning.*
>
> *Students helped each other take notes...the group activity was much more active than previous group work.*
>
> *I feel more positively disposed to technology primarily because the students reacted with enthusiasm.*
>
> *The interactive technology helps shift the onus of the learning process from the teacher to the student...it helps make teaching/learning become more student centered.*

The faculty comments above were validated by comments made by the outside evaluator and by the students. In general, the program provided an active teaching/learning environment that put the student at the center of the activity.

During interviews, faculty participants were asked to identify any problems they had in using the program and their suggestions for improving it. Below are some of their comments:

> *The accents of the characters at times were difficult for ESL students.*
>
> *I had difficulty using the mouse and facing the class.*
>
> *We could have used more equipment.*
>
> *They [students] found it easier to use laser disc technology...easier than I did.*
>
> *I had to spend a good deal of time in organizing and planning learning activities to be used in conjunction with the program.*

Student reactions to the program were mixed. A sample of their comments included:

> *It required both me and the professor to become involved with the activity.*
>
> *I do not like to take notes...I would have been better able to grasp the material by watching and listening.*
>
> *While entertaining...it was difficult concentrating on too many ideas and facts.*
>
> *. . . easier and faster than going to the library.*
>
> *. . . too complex and too fast.*
>
> *I do not like computers...and I did not like the accents of the characters.*
>
> *I liked the fact that the characters spoke...and I enjoyed their accents.*
>
> *I closely identified with the Mary Mulvahill [Irish immigrant mother] character.*
>
> I *continued to think about* the Five Points *after class in relation to poor people today.*

The findings from this evaluation provided valuable insight into how the program functioned in other teaching and learning environments. They indicate that the program worked in several different courses taught by different faculty who attempted to meet a variety of student needs. In general, faculty, student, and the independent evaluator's reactions were positive and indicated that the model was effective and would be appropriate for other multimedia programs dealing with similar content. Students from diverse backgrounds related well to the social history content and the plight of the characters depicted in the program. However, many of their comments required careful consideration on the part of the developers for future projects incorporating the model. A brief discussion of several of these considerations might prove helpful to others interested in the instructional design of multimedia software.

The use of accents in the video portions of the program for instance attracted many reactions on the part of faculty and students. While some liked the accents, others had difficulty with them particularly students with limited English proficiency. Accuracy in depicting the historical event requires that recent immigrants be depicted as speaking with accents. On the other hand, if accents prove problematic for some students, should they be eliminated? The decision of the developers was that accents should not be eliminated but "softened" for future programs. In addition, any ethnic terms or slang expressions would be defined in the archive room's dictionary. Another approach still under consideration is providing text of the words on the video display as they are being spoken in the program.

The speed of the program also attracted mixed comments. Students generally needed from three to six hours to complete the assignment depending on their writing abilities, familiarity with computer equipment, and research skills. While some considered the program too fast, others considered it slow. This was discussed extensively during the design and development of the program. Several features designed to speed up or slow down the program were tested, and the decision was made not to emphasize speed in using the program. The consensus of the developers was that faster learning is not necessarily better learning particularly when dealing with subject matter designed to stimulate points of view. The design of future programs will emphasize a deliberate, and if need be, slower navigation through the program. The rationale for this decision was that the frustration levels would be higher for those students who find the program too fast as opposed to those who find it too slow.

The complexity in using interactive technology particularly in terms of navigating through the multimedia program also became an important evaluation issue. The program was designed to be easy to use. A major criterion for selecting the four faculty participants was that they not be particularly computer proficient. The proficiencies of the student participants were not controlled. The outside evaluator observed that students with some computer proficiency were better able to navigate through the program than those with little or no proficiency. Two of the faculty participants commented that their students found the program easier to use than they did. The developers of the program will continue to emphasize ease of use in designing future programs in that navigating through a multimedia program while becoming more commonplace, is still a relatively new experience for many faculty and students.

Application

Videotape material from the original *Who Built America?* series has been used in more than five hundred colleges and high schools across the country. The multimedia programs based on the above model would also be appropriate in these settings. As mentioned above, the programs have already been used in a variety of subject areas including teacher education, sociology, basic writing, communications, and human services.

In terms of advancing the use of technology in Hunter College's teacher education programs, the development and evaluation of the social history model and the subsequent programs have become valuable resources. In the educational technology courses, the development of the model has provided a wealth of information on designing instructional multimedia software applications. The evaluation likewise has provided a good deal of data regarding teacher and learner interaction with technology much of which can now be demonstrated using videotapes from the LaGuardia Community College study. Technical design issues such as those presented above on the speed or navigational complexity of multimedia programs are easily demonstrated and documented. Content issues such as the use of accents likewise provide important insights to the complexity of designing and using software for diverse student populations. Students in educational technology have also begun to use the model as a "shell" in workshops for developing their own mini versions of the programs.

Perhaps the most significant contribution to the advancement of technology in the teacher education program has been the potential of integrating these programs into other education courses that do not necessarily focus on technology. The first program, *The Five Points...* has already been used in the social studies methods and the social foundations of education courses. Discussions are presently underway for using the program in a section of the methods of teaching language arts course. Because the content has appeal to a variety students, many of whom are recent immigrants themselves, the programs integrate easily into other courses with a modest amount of staff training and development.

Conclusion

The development of multimedia software for teaching social history has provided both faculty and students in Hunter College's teacher education programs with a model for combining provocative historical content with modern and stimulating educational technology. In some ways, it is a 1990s variation of the traditional concept that effective teaching requires significant content as well as good pedagogical technique.

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Interactive Multimedia: Cognition and Motivation in the Context of Teacher Enhancement

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Several cognitive and motivational theories may be found in the research literature as frameworks which describe the process of learning from interactive multimedia. In this paper, the primary question addressed concerns how these mechanisms work to promote teacher learning from interactive multimedia. Special emphasis will be given to the use of computer-based video because it is in the integration of the two that allows the term "multimedia" to suggest an instructional environment that can be used to facilitate learning (Kozma, 1991). The nature of the research literature also proffers an antecedal question of how to apply child learning research to adults, and this will be discussed here as well.

Integration of Literature on Student and Adult Learning

Much study in the area of interactive multimedia has been given to the cognitive and motivational impact of interactive video on children rather than adults. The psychological mechanisms of learning can be the same for both types of learners because the mechanisms themselves appear to be universal. Some time-dependent differences may still exist because of the broader social history and context of adults, but these differences are generally ascribed to socialization rather than to psychology (Richey, 1992). For example, one may need to distinguish between a ten year old child and a thirty-two year old teacher when attempting to account for a learner's preconception of how he or she learns and is motivated to learn from video (Cennamo, Savenye, & Smith, 1991).

Psychological mechanisms germane to child learning may be applied to adult learning as long as the possibilities of difference are seriously analyzed. Wittrock (1991) mentions the practice that children have of resolving cognitive dissonance between their views and scientists' conceptions by discrediting data that does not support their own theories. He describes one strategy for the teacher of these children as the introduction of dissonance based upon data which is grounded in their experience, data that is less likely to be dismissed. This entire scenario could be reconstructed for adult learners if the children are transformed into classroom teachers, the subject is transformed from science to pedagogy, the classroom is transformed into a multimedia software environment, and the scientists are transformed into educational researchers. The "grounded" data in this new scenario could be classroom video and establishing context, in the form of text, audio, other video, etc., which either comes from the learner's own classroom or another which he or she can identify with.

An analysis of the possibility of difference between these scenarios may proceed as follows: the robustness of the theories of either the child or the adult learners can vary according to the depth of experience or expertise they believe they possess in the domain of interest. Adult learners may have especially robust theories because they have operated by them as professionals for many years. It may be particularly incumbant upon the designers of an interactive multimedia environment for teacher enhancement to show a multiplicity of contexts, such as video of several diverse classrooms. The teacher learners could thus see the merit of the dissonant theory established in several contexts, with data that is not easily dismissed.

Cognitive Mechanisms

At least three cognitive models are recognized as governing frameworks for learning from interactive multimedia. They are cognitive flexibility, situated cognition, and the Dreyfus Skill Acquisition Model (Bransford, Goldman, & Vye, 1991; Hansen, 1989; Spiro, Feltovich, Jacobson, & Coulson, 1991). Cognitive flexibility theory, according to Spiro, et al., is "doubly constructive" in that the learner constructs (or perhaps reconstructs) what he or she perceives as relevant prior knowledge for the situation at hand, and then uses that prior knowledge to help construct new understandings beyond what is obvious. Cognitive flexibility is especially geared towards ill-structured domains, where there is a great deal of complexity within both the domain and individual cases of that domain, yet there is appreciable inconsistency from case to case. The notion of a reconstruction of prior knowledge is useful if one believes that the prior knowledge itself is contextualized within experiences which resemble the situation at hand only in peculiar and important ways and therefore requires some alignment of details in order to be applied (Schank & Osgood, 1993).

In application to instructional multimedia design, one would attempt to revisit the same material, but at different times for different reasons. For example, if a teacher learner is accessing a multimedia database related to a novel theory of pedagogical practice, the interface could present diverse perspectives on what is contained in the database. These might include perspectives from one or more classroom teachers, educational researchers, administrators or support staff, parents, and students. The perspectives could be integral, addressing the theory as a whole, or differential, addressing individual aspects of the theory. The tone of these perspectives might range from the abstruse, with definitions and rationales, to the visceral, with dilemmas about conflicts with teacher beliefs, to the pragmatic, with challenges regarding implementation. The media of delivery may be classroom video, talking head video, hypertext, audio, animation, still photograph, etc. Variations of perspective, such as different video camera angles or different audio sources, can also be utilized.

An important precursor to the understanding of situated cognition (Bransford, et al, 1991) is the existence of inert knowledge. Inert knowledge is that which the student believes has been learned but which remains unused in situations which should call for its use. Inert knowledge can be constructed when there is a lack of focus and/or context surrounding its acquisition. Situated cognition would help in the construction of active knowledge by the creation of "a shared environment that makes contact with students' intuitive knowledge, permits sustained exploration by students and teachers, and enables them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools." (Bransford, et al., 1991, p. 170).

Cognitive flexibility and situated cognition are "cousins" in the sense that both center learning within problems to be solved, build upon the learners' prior knowledge, support opportunities for generative learning, require their contexts to retain real-life complexity, and make use of multiple perspectives of the situation at hand. Both are at odds with rule-based learning and analogical learning when the rules and analogies are not developed by the learner. They differ in that situated cognition is inherently collaborative and needful of an explicit learning goal, while cognitive flexibility can be individual or collaborative and can work towards an implicit goal. Situated cognition thus resembles a connectionist model of knowledge representation (Bereiter, 1991), while flexible cognition maintains a link with schema theory even as it elaborates on it.

The application of situated cognition to interactive multimedia can be similar to that of cognitive flexibility, but would still be distinct. Contact *must* be made with the intuitive knowledge of a specific group rather than with a collection of individuals. For example, suppose that the problem-solving context within a multimedia environment is river navigation by boat. If that context is not culturally relevant to the group of teachers attempting to learn from this system, then such contact may not occur, and situated cognition becomes more difficult. In the case of cognitive flexibility, connection need only be made with individuals who do not have to be in one physical space or cyberspace at one time.

Since situated cognition requires a specific learning goal, it is important that the multimedia environment either clearly supports an acute goal presented elsewhere or presents the same itself. By contrast, cognitive flexibility does not attempt to isolate a goal because it is not designed to filter out the acquisition of inert knowledge. Instead, it is up to the learner to construct what he or she will, according to his or her own goals or lack thereof.

The Dreyfus Skill Acquisition Model (Dreyfus & Dreyfus, 1986) consists of a progression by the learner through distinct linear stages, called Novice, Advanced Beginner, Competence, Proficiency, and Expertise. The beginning state is one who is only able to learn context-free rules for acting upon relevant facts and features within a situation. The end state is one who intuitively knows what to do within a situation based upon mature and practiced understanding. There is no imposition of conditions such as collaborative environments or ill-structured domains. Instead, this is a top-down method, which stands in contrast to the bottom-up methods described previously. Hansen (1989) notes that no rationale exists on how to proceed from one stage to another in the linear Dreyfus model. It is possible that the difficulty of moving across a stage differs from stage to stage as well, so that certain stages in this model can become learning bottlenecks.

The importance of having structure in a computer-based learning environment was suggested by Ford & Ford (1992), who noted that some learners who were free to choose their own learning path through an idyllic expert system were unable to reach their learning objectives. A stand-alone model like the Dreyfus' would provide a concise set of design principles for guiding a learner from the beginning state to the end. This type of structure would not have to be part and parcel of the software in order to be utilized. Lampert, Heaton, & Ball (1992) and Krajcik, Blumenfeld, Marx, & Soloway (in press) are developing multimedia databases for teachers, where the structure is introduced in a class or worksession. A top-down approach such as the Dreyfus model, in concert with a bottom-up method such as cognitive flexibility or situated cognition, would provide the interface designer with a structure and a type of path through that structure. Schank, Ferguson, Birnbaum, Barger, & Greising (1991) describe the difficulty of attempting to build a link between a top-down and bottom-up approach, but appear to have discovered no generalizable design secret other than that everyone associated with the design should be intimately familiar with all of the multimedia data.

Motivational Mechanisms

Much has been said about the inherently motivating aspect of video (Cognition and Technology Group at Vanderbilt, 1992; Cronin & Cronin, 1992; Hansen, 1989; Salomon, 1984; Spiro, et al., 1991;), but relatively little on why. A motivating feature of video that is often cited is realism, the rationale being that the video can allow the learner to view a realistic portrayal of the classroom (Barker & Manji, 1989). However, a given multimedia environment contains the fingerprint of its designers. It tells a story of some type, and all of the supporting media help to tell that story rather than to portray some sort of stark reality. Even a neutral piece of software such as a multimedia encyclopedia reflects people's perceptions of what merits inclusion and what each entry is to say. Any single video clip alone should not be expected to portray reality.

The principal motivational mechanisms identified have centered around self-efficacy and perceived task difficulty (Clark & Sugrue, 1987; Cronin & Cronin, 1992; Salomon, 1984). With regard to learning, perceived self-efficacy can refer to students' beliefs about their ability to utilize the knowledge and skills they possess to learn new skills (Schunk, 1989). Self-efficacy can work against learning from multimedia if the learners consider themselves to be of below-average ability when working with computers. Unfortunately, this can be a common mode for teachers (Marx, et al., 1994; Ladewski, Krajcik, & Harvey, 1994).

Clark & Sugrue (1987) have concluded that task motivation is derived from the answers to three implicit questions the learner poses regarding affect, perceived task difficulty, and self-efficacy. If the task concerns learning via multimedia, the first answer may involve factors such as a reaction to the aesthetics of the interface, a resemblance to a previously encountered interface, etc. The latter answers would then influence the degree of effort made, bearing in mind the relationship between the two of an inverted "U" where maximal effort is made for intermediate degrees of perceived task difficulty and self-efficacy.

The level of intrinsic motivation at work within this learner is believed to be affected primarily by their perception of how hard they must work at learning. One measurable construct used by Salomon (1984), called AIME (amount of invested mental effort) may be directly proportional to intrinsic motivation. AIME was defined as the number of nonautomatic mental elaborations applied to a learning task. In looking at how successfully children were able to learn from print as opposed to learning from instructional television, Salomon believed that the key difference was inference-making. The video-learning students made fewer elaborations because they perceived the medium as more realistic, and tended to simply port what they saw into a mental representation. The print-learning students perceived their medium as more contrived, and made a larger number of elaborations in order to transform the written text into a suitable mental representation. Salomon also found that external attributions were made for successful video learning, and internal ones made for successful print learning, and that there were more instances of successful learning in the latter case.

Rosmiszoski (1986) notes that the precision needed for communication via instructional media is greater than it is for entertainment or artistic media. One who views a television program or watches a play may only need the gist of a story, based on emotions and impressions rather than facts and concepts. However, in the case of a teacher viewing instructional video within a multimedia environment, it is quite likely that the video has been selected because it efficiently conveys or helps convey information. It must communicate with great precision because of factors such as current technological limitations on the storage available on media such as CD-ROM or videodisc. This teacher would have to somehow lay aside a preconception that watching this instructional video can be done with the same level of mindfulness as watching entertainment or artistic video. He or she could be aided in doing this by the interface or as part of a preparatory preview.

Importance of Accounting for Preconceptions

All three models of cognition described previously point to a need to directly account for learner preconceptions. Emergent issues for teacher education can concern content knowledge (CK) and pedagogical content knowledge (PCK). For example, due to an ongoing shortage of teachers trained in science, many science teachers have been "drafted" into the profession who do not possess the degree of CK/PCK normatively desired. One often finds a wide spectrum of CK/PCK background within a given body of science teachers. Interactive multimedia environments for science teacher enhancement which do not account for this spectrum - which do not scaffold the generation of CK/PCK by these "draftees" in one way or another - may be doomed to fail a substantial portion of their intended audience. An example of scaffolded PCK might be to show video clips of several science teachers teaching different science content in a similar manner, and then use textual and audio commentary to elaborate how that manner is similar in these different classroom contexts (Blumenfeld, Soloway, Marx, Krajcik, Palincsar, & Guzdial, 1991).

The effect of motivational preconceptions can enter the picture at the same juncture. These "draftee" science teachers can remain quite aware of their shortfall in CK or PCK even at mature stages in their career. Their self-efficacy may consistently be at a point where it can stymie intrinsic motivation to learn. This issue is made even more daunting when self-efficacy about computer usage interacts as well. The system design may need to provide the learner with tactical control over the rate of learning while retaining strategic control over what can be accessed at any given time. The key would be to maintain the teacher learner within a zone of proximal development, integral with CK/PCK and interface navigation, where the proximus is either with peers or with themselves at a different point in time. One way to promote self-efficacy may be to may help reduce perceived task difficulty, since the two are part of a feedback loop. This may lead to some humanizing of the design such as the use of teacher docents in the interface or the use of the unique flavor of "teacher language" in semantics and conceptual organization. Such strategies would give the teacher an assurance that a path to understanding had been trodden upon by other teachers.

Conclusion

One point that has begun to emerge is that there may never be a fully generalizable set of design principles which would optimize one's opportunity for learning. Design rationales may always need to iterate with domain knowledge (Chiou, 1993). For example, the design principles utilized by CGTV (1992) are described as a gestalt. Therefore, careful thought should be given to the ways in which teacher enhancement is a unique domain requiring unique design strategies. Examples of these thoughts have been elaborated upon here, but many more will need to come along.

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Introducing Discussion Leading Strategies with a Videodisc Lesson

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> *Whoever lacks this trust [in the oppressed people's ability to reason] will fail to initiate (or will abandon) dialogue, reflection, and communication, and will fall into using slogans, communiques, monologues, and instructions. Superficial conversions to the cause of liberation carry this danger. (Freire, 1970, p. 53)*

Videodisc technology has been gradually working its way into the elementary science methods course at Cleveland State University. A locally produced videodisc of a science lesson, controlled with in-house developed software, has been used for informing and modeling for elementary education majors an instructional approach that is otherwise insufficiently demonstrated. Concrete strategies that facilitate whole class discussions form the core of the instructional model advocated within the elementary science methods course. This paper discusses the potential for videodisc technology as a tool for teacher preparation.

The Local Teacher Education Program

The general methods course, taken early in the professional course sequence, is structured around a direct teaching model in which the teacher serves as a provider of information. Research has demonstrated that instruction characterized by guided and independent practice effectively supports students' abilities to learn content that is clearly defined and hierarchical in nature (Good & Grouws, 1979). Unfortunately, many students leave the university believing that the direct teaching model should be the dominant means for dispensing knowledge to students. Alternative instructional models, such as an inductive approach, are not given sufficient emphasis.

Within the teacher preparation program at Cleveland State University, students aspiring to be elementary school teachers are given several field experiences in the local urban and suburban schools. From one field experience to the next, students are gradually immersed into area classrooms. While enrolled in the language arts and mathematics methods courses, students focus upon teaching in these specific subject areas. The teacher preparatory program culminates with the traditional full-day student teaching experience. In addition to these field based courses, students also take subject-area specific methods courses in art, music, physical education, social studies, and science; none of these coincide with a field experience. Consequently, during these subject area methods courses, students are not required to put into practice the techniques and approaches taught by the University instructors.

A Model for Supporting Science Discussions

The instructional model advocated for use in the elementary school classrooms during the science methods course is the Learning Cycle. This model of science teaching has taken several different forms (e.g., Biological Science Curriculum Study, 1993; Education Development Center, 1993) but the essence of the Learning Cycle remains the same in all of these instances. In the Learning Cycle

Model developed by Jack Renner (Renner, Abraham, & Birnie, 1988) students begin their study of a concept with firsthand experiences. Within the Cleveland Public School District's elementary science reform effort (Sandler, Flynn, & White, 1992), the first phase of the cycle is called *Exploring and Discovering*. The next phase of the cycle, *Processing for Meaning*, involves students in the sharing of their observations and ideas including some instruction by the teacher that is intended to begin solidifying students' emerging science understandings. In the final *Extending* phase of the cycle, students engage in additional hands-on experiences in which they apply their new understandings to novel situations.

A challenge that both seasoned and novice teachers have as they attempt to implement the Learning Cycle is the *Processing for Meaning* phase during which the students articulate and refine their grasp of science concepts. General guidelines for facilitating whole class discussions are available (e.g., Dillon, 1984; Gall and Gall, 1993), but they fail to provide substantive strategies couched in a theoretical framework. The Instructional Conversations Model (Goldenberg, 1991), although originally developed for language arts instruction with children who have limited English proficiency, seems to hold promise as an approach that could apply to science discussions. The ten elements of the Instructional Conversations Model (from Rueda, Goldenberg & Gallimore, 1992) are listed below:

a. A challenging but nonthreatening atmosphere
b. Responsivity to students' contributions
c. Promoting discussion
d. Connected discourse (ideas build upon each other)
e. General participation including self-selected turns at speaking
f. Maintaining a thematic focus
g. Activating background information
h. Direct teaching when necessary
i. Promoting the use of more complex language
j. Promoting the use of evidence to support statements

The strategies represent a constellation of teacher actions intended to encourage student-to-student interactions in such a way as to promote a constructed social understanding about natural phenomena. One of the goals of the elementary science methods course at Cleveland State University is for the students to develop the skills necessary to facilitate quality group discussions among children. A videodisc of a science lesson was pressed into service as a potential tool for making this goal a reality.

Videodisc as a Modeling Tool

A videodisc was produced that showed a science education professor teaching a two-day lesson to preservice elementary school teachers (Settlage, Benghiat, & Abate, 1993). The concepts developed during this lesson were physical and chemical properties and the lesson was taught with the Learning Cycle approach. Students viewed eight selected segments from the videodisc in pairs. A *Hypercard* stack was developed to serve as both a control and data recording tool.

With just six multimedia setups, half of the students worked in the computer lab while the other half remained in the science methods classroom. The group in the computer lab received only minimal information: instructions about how to manipulate the software but essentially no directions about the Instructional Conversations Model . Their task was to select the Instructional Conversation element demonstrated in each video clip, estimate the ratio of teacher to student talk, and make any notes that might be useful for later reference.

The group that remained in the science methods classroom was given direct instruction about the Instructional Conversations Model . These students viewed a video from a completely different science lesson and, with the support of the instructor, identified the use of the various Instructional Conversations elements. At the end of this session, the two groups swapped classrooms. The students who now occupied the computer lab had a greater initial understanding of the model and undertook the same task as their classmates. Meanwhile, the students who had started in the computer lab viewed segments of the original video lesson. Students were asked to share their thoughts about the Instructional Conversations elements and requested to justify the element that they selected.

Discussion

When the videodisc was produced, the developers were not yet aware of the Instructional Conversations Model . The original intent of the videodisc was to demonstrate the phases of the Learning Cycle. Consequently, it has been difficult to locate segments of the video that definitively demonstrate given elements. Even though masterful modeling of the elements do not always appear, the discussion among the students about what elements may be taking place have proven quite fruitful. After being introduced to the Instructional Conversations Model , students begin planning a microlesson that they will teach to their peers. These microlessons are audiotaped so that each student can later listen to the discussion segment. As they listen to the tape of their fifteen minute lesson, the students rate their implementation of the Instructional Conversations elements using the rating system developed by the inventors of this model (Rueda, Goldenberg & Gallimore, 1992).

Our contention, and that of others who have been researching science discussions (e.g., Brown & Campione, 1990), is that children's learning of science occurs much more effectively when they are given multiple opportunities to express their thoughts about science and listen to the ideas of others in a supportive forum. Traditional modes of science instruction do not provide opportunities for students to articulate their ideas, express or explain their reasoning, or request input to clear up misunderstandings (Yackel, Cobb, Wood, Wheatley & Merkel, 1990). The kind of learning opportunities that are precluded by teacher dominated lecture can be made available to children when the control of the discussion is passed from the teacher to the students.

The hope is to someday conduct follow-up studies of students implementing these strategies in the classrooms where they student teach. Their appreciation of the Instructional Conversations Model is a cause for hope, but the true test of the effectiveness of the videodisc as a tool for training preservice teachers will occur in real classrooms. A concern is that, in the midst of all the challenges of leading an inductive, hands-on science lesson with elementary school children, that the effects of the training may be diminished. Yet, based upon comments made by our students after learning about this model, we anticipate that the positive effect upon group discussions of the Instructional Conversations elements will reinforce their use. The dream is for elementary school children to engage in substantive and constructive dialogue about the science concepts that they experience. A step toward creating this situation is providing elementary education majors with the teaching strategies that support educational conversations.

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Catching the Dickens: A Multiscreen Journey into the Myth Continuum

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How often the names of historically significant people are tied, for fame or shame, to one major event or element in their lives! Because Dr. Mudd set the broken leg of assassin, John Wilkes Booth, we *remember* him forever with the expression, "his name is mud." We *honor* the classic auto designer, Duesenberg, every time we label a product, " a doosie." But we *dishonor* the great author, Dickens, every time we use the phrase, "catching the Dickens" because we identify his person with the one thing he abhorred, the cruel treatment of children in 19th Century England.

The Dickens "trouble" name, however, identifies a small area of his world. The much larger world of Dickens is available to student teachers "outside the bubble" when watching students "inside the bubble." Student teachers observing a multimedia teaching situation, can enter the larger world of Dickens, better discern how multimedia processes actively engage students, and develop scripts for their own production of multimedia materials. The students "inside the bubble" can see Dickens as a model for personal achievement; they can see elements in his works as a map for over viewing those works, and they can see his values as a matrix for comparing and contrasting his personal myth with the myth about which he writes, the societal myth which youth encounters, and the personal myth of each researching student.

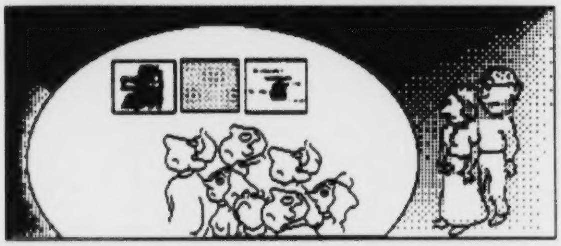

Figure 1. Inside and Outside "the Bubble."

What Happens "Inside the Bubble?"

In a multimedia cyclic movement from a HyperCard left screen to a Videodisc central screen to overhead menus third screens, students learn to assess and own their own values and to contrast those with values of others. They observe a **left** screen narrative of the Dickens' story, in which as an eleven year old English 19th Century youth, he escapes from a twelve hour job in a bottle factory through his discovery of his own innate ability to write, and in which he, as a mature adult, incorporates his own story in *David Copperfield*, focuses on the secret of childhood, and reflects the values of his time. They view a left screen description of the different phases of the Dickens experience from serial writing to his later planned novels. And they see his productive as well as his discouraging moments when the words will not come. They observe the content necessary for enlightened discussion in the story narrative and see that content reinforced on the central screen.

They then alternatively see on the *central* videodisc screen four illustrative and reinforcing vignettes from *Great*

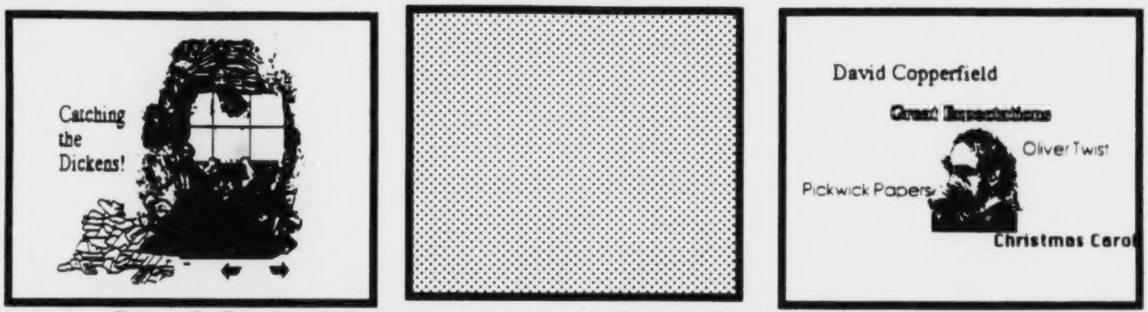

Figure 2. Two HyperCard Screens, Left and Right, plus a Center Videodisc Screen.

Expectations. These vignettes are illustrative since they display the childhood journey of Pip and Joe, the secret of childhood in a Christmas scene, the compassion of Pip, and the machinations of the moneyed broken- hearted Mrs. Havisham who plots to break Pip's heart.

What About the Teacher "Inside the Bubble ?"

What will the teacher be doing during this student viewing of the narrative? Since, as McLuhan has shown, the sound medium pulls students from participation to observation, the skillful teacher will bring them back to interaction through *right* screen punctuated overhead menus and accompanying worksheets. While the teacher can involve the students at any point in the three screen narrative, she is expected to stimulate the students after the Videodisc vignette to move from the observational mode to the participatory mode. She provides for the students right screen menus which are reflected in the four worksheets. These worksheets with a mix of text and graphics invite students to enter a time parallel to that of Dickens, Pip and Joe; to search the secret of childhood; to trace different works in the Dickens collection to different elements in the myth continuum; and to describe the matrix of Dickensian values and to suggest a route of researching those.

The students journey through each cycle from left to central to right screen from less to more intense involvement in the world of Dickens. At the end of one cycle a new cycle begins as the left screen Dickens narrative brings the students back to the life of Dickens, until arriving at the vision of the child as seen in several of the Dickens novels. The central screen reinforces this vision through a Christmas scene in *Great Expectations* in which both negative and positive visions of the students can be seen. The students are reintroduced to the participatory mode through a worksheet and a right screen transparency menu.

After a second cycle the students are asked to find the literature of Dickens as part of a continuum from myth to parable. The Myth continuum from myth through apologue, action, satire and parable is borrowed from J. Dominic Crossan's *The Dark Interval*. And the definition of Myth "invention about truth," is borrowed from Tolkien. At this point students are asked to pick a myth of their own time and culture such as "might makes right." They are then asked to suggest different popular arts pieces which reflect those different aspects of the myth continuum. They might also explain why conflicts occur when opposing myths meet.

After the discussion terminates the second cycle, students are reintroduced to the left screen on which is narrated a preoccupation with money and its use as a control instrument. Dickens' presentation of the money myth is reflected in the middle screen, *Great Expectations* vignette of "broken hearted" Mrs. Havisham who urges her niece to lead Pip on and to "break his heart." She controls her niece, as well as Pip through her wealth. And Pip will buy into the myth that money is the path to education which is the path to the successful and happy world.

Having moved from participation to observation, the students are again brought back to participation through a right screen menu and worksheet on which appears the galaxy matrix view of Dickens' world. The matrix is open to the hierarchical placement by students who arrange friendship, family, relationships, money and other values as the central sun, planets and moons in Dickens' Galaxy. The students place these values on a worksheet. After they have discussed, and shared different points of view, they are to explain a research design to show that their matrix of Dicken's myth was really his. They might suggest a shared viewing of his writings in which they do factor analysis by identifying occurrences and frequency of the different themes in his works. They might suggest searching the autobiographical work, *David Copperfield*, or they might even look at the several biographies of Dickens which are available. However, even after identifying sources, they need to provide a strategy for evaluating data.

What Happens "Outside the Bubble?"

And what are the students "outside the bubble" doing while the students "inside the bubble" are entering the world of Dickens? Student teachers are opening themselves to the world of Dickens as are the high school students. But the student teachers are also in a position to critique the process. They can assess the teacher's ability to engage students interactively with the multimedia program. They can make several McLuhanesque observations about how "hot" media items supplying much information discourage participation while "cool" media items supplying little information encourage participation. They can also conclude that the left and right screen are generally "hot" media, while the worksheets and right screen transparency menus are "cool" media.

The student teacher can suggest ways to improve the "hot" medium story narrative as a HyperCard process, and ways to better involve the students. They will observe that the central screen videodisc which reinforces the left screen story narrative puts students in a totally observational mode and will require worksheets or menus to reintroduce students to participation.

The student teacher can observe that the professional quality of the worksheets employing text and graphics merits professional response by the students. The student teacher can also observe the increased involvement of students through identification with Dickens and the characters in the narrative, to involvement with two of his themes, the heart of the child and the galaxy of personal values. Having evaluated the plan and the process, the student teacher can suggest ways of making these media more effective, and perhaps provide innovations in media usage to generate a whole group of writers "catching the Dickens."

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Assessing and Creating Literacy Through Hypermedia Portfolios: An Undergraduate Project

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Hypermedia portfolios are extremely valuable for both assessing and creating literacy in students of all ages. Undergraduate education majors enrolled in a diagnostic reading course at Winthrop University assess literacy in at-risk elementary students using hypermedia technology and then remediate the students' needs by creating literacy events in a multimedia environment. This literacy related information is contained in a computerized portfolio the undergraduates complete after tutoring an at-risk elementary student for a semester. There are two components in the portfolio: the assessment component and the creative component. The assessment component contains testing data and the creative component contains the instructional activities.

The interactive hypermedia assessment component allows for data to be entered at any point and decision-making activities to occur simultaneously. The type of information entered by the undergraduate students included writing samples of the at-risk students with analytic scoring guides, formal and informal test data, teacher observations of student behaviors, oral language samples, video clips of teacher-student interactions and dialogue, background information supplied by the parents, and other pertinent data. The creative, multimedia component is comprised of instructional activities that are literature-based and centered on the needs of the student as portrayed in the assessment component.

The portfolio becomes a living, process-oriented computerized document that can grow and change with the needs and capabilities of the at-risk student. Literacy events are created when the assessment data is used to develop multimedia applications that are tailored to suit the individual student's needs. These interactive creations provide opportunities for writing, reading, listening, and speaking that are student-centered and holistic in nature. Figure 1 indicates the symbiotic relationship between the assessment and the creative components of the portfolio.

Assessing Literacy using Hypermedia: the First Component

Literacy assessment using interactive hypermedia is a relatively new endeavor in the field of remedial reading.

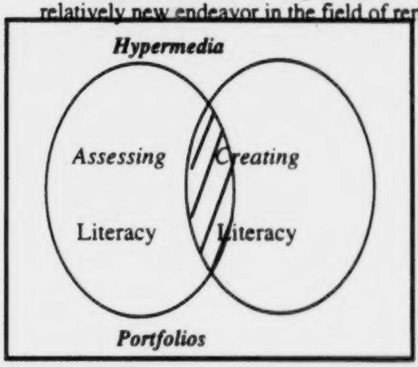

Figure 1. Relationship between Portfolio Assessment and Creative Components.

Historically literacy has been reported as a series of product-oriented, quantitative statements that are static, linear, and unidimensional. As a result, qualitative changes in student competence in areas involving literacy often went unnoticed and unreported. The hypermedia portfolio was designed to overcome these literacy assessment deficits and create a technology-based document that changed with the student.

Philosophical Underpinnings

The philosophical underpinnings of the diagnostic reading course determined how the technology would best be used for the hypermedia portfolios. This philosophy dictated that the portfolio would be based on a language-oriented, holistic, student-centered approach to teaching and remediating reading deficiencies in at-risk students. As a result, the assessment component was developed as a process-oriented document that would allow for a variety of sources of assessment data that included both formal and informal data. HyperCard 2.1, available from Claris Corporation, was selected as the tool for creating the hypermedia portfolio.

Portfolio Content

Each portfolio contains a home card that connects interactively to the various sources of assessment data. The sources for the assessment portfolio include assessment data from an informal reading inventory, oral reading miscue analysis, interest inventory, writing analysis, spelling profile, teacher observations, and background information on each student. Undergraduate students entered the data into each HyperCard portfolio stack. They were also responsible for scanning the writing sample into the portfolio, recording the student's oral reading sample, capturing the video, and compiling the printed report into a document that was made available to parents and teachers. Figure 2. shows the format for the home card.

Navigating Through the Portfolio

Users of the hypermedia portfolio navigate through the stacks in any direction in a nonlinear fashion. For example, one could begin the examination of literacy by looking at the assessment results and then decide to examine the student's background. Or it may be advantageous to view the video clip first to get a mental image of the student and then review assessment data. The person operating the program determines the course to follow.

Creating Literacy Experiences: The Second Component

After the assessment data have been entered into the portfolio and analyzed, the undergraduate student develops instructional multimedia lessons for the at-risk student based on the conclusions from the data. The lessons are also interactive, HyperCard-based but include laser disc and CD-ROM access.

Using technology to *create* literacy experiences can be a time-consuming process if prior planning for the instructional unit has not occurred. Once the planning stage has been completed, however, the creation of a multimedia event can be both exciting and motivational for the student. Steps for using the assessment information to create literacy events are included below.

Step 1. Using the Assessment Data

It is important to use the assessment information to develop multimedia lessons that will target each at-risk student's strengths and weaknesses in reading. This information is summarized on the conclusions card in the portfolio. The synthesized data serves as the link between the assessment component and the creative component.

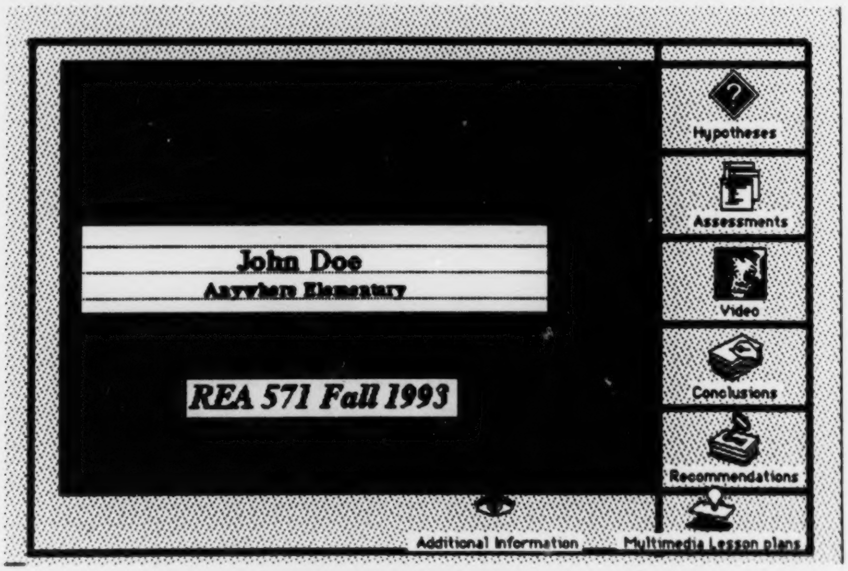

Figure 2. The Hypermedia Portfolio Home Card.

Step 2. Selection of Literature

A second step involved identifying several good works of literature that can be used as the core for instruction. Using a book that targets the identified needs of the student is indeed an important challenge. For example, if the assessment results indicate that a student has difficulty with the sounds of language, the book *Bringing the Rain to Kapiti Plain* by Verna Aardema may be an appropriate core book. This book provides basic graphophonic elements that are embedded in a meaningful, motivational context that provide redundancy, numerous opportunities for vocabulary enhancement, and growth in experiential knowledge. The reading level makes it appropriate for the student to read the book independently or as a shared-reading experience. Selection of an appropriate work of literature, therefore, should be based on the possibilities the book has to offer, the approximate reading level, the potential for instructional strategies for reading growth, and the interest level of the student.

Instructional focal points are most efficient when more broad than narrow. For example, appropriate focal points for a multimedia lesson could be one of the following:

- graphophonic awareness
- literal comprehension
- critical comprehension
- vocabulary growth
- organizational/study strategies
- writing skills
- content area connections

Step 3: Defining Connections

When defining connections, it is important to determine what the instructional focal points will be. For example, the core book *Bringing the Rain to Kapiti Plain* could be used to reinforce the following reading strategies:

a. graphophonic awareness;
b. critical thinking, especially comparing and contrasting;
c. geographic literacy and awareness; and
d. writing opportunities based on visual information.

The student completes activities related to each of these focal points that are contained within the portfolio. Figure 3 shows these interactive connections.

Step 4: Developing the Interactive, Multimedia Lesson

To proceed with this step, the instructor must have a basic understanding of the software that allows for interactive actions to occur. For example, undergraduates at Winthrop use HyperCard 2.1 to develop the interactive lessons along with software that controls the laser disc player. In the example below, the book *Bringing the Rain to Kapiti Plain* is divided into three segments: reading the story for vocabulary and graphophonic awareness; writing activities for critical thinking; and viewing laser disc clips for geographic literacy. Each of these components is described below:

Reading the Story. The text of the first two pages of the book are entered into the HyperCard stack and are read to the student by clicking on the oral reading button. Highlighted words from these pages are also pronounced individually so that the student can hear the story and the targeted vocabulary as often as needed.

Writing Activities. After the pages are read, the student responds to several open ended questions concerning the story. The student also completes a Venn-Diagram comparing and contrasting the wetlands and the dry African plain.

Laser disc. The at-risk student then accesses appropriate laser video clips on the African continent that reinforce geographic literacy and enhance visual literacy.

The student uses this component of the portfolio to actually work on areas of strength or deficiency. Of course, these instructional activities can be modified at any time as the needs of the student change.

Conclusion

The dual-component hypermedia portfolio is a valuable tool that includes both assessment data and instructional activities based on that data. The self-contained nature of the portfolio makes it easy to make necessary changes and adapt to student needs as warranted. It is most applicable, however, in small tutorial situations where individualized instruction is suggested and would be difficult to implement in whole class settings.

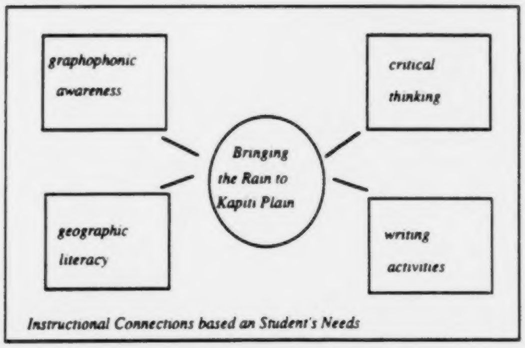
graphophonic awareness
critical thinking
Bringing the Rain to Kapiti Plain
geographic literacy
writing activities
Instructional Connections based an Student's Needs

Figure 3. Instructional Connections.

Electronic Children's Books: The Good, The Bad, and The Hype

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University of Arizona

Preservice teachers generally take courses in children's literature or adolescent literature so they can learn about the history of literature, the various genre, authors, and appropriate stories available for use in teaching. Such courses typically deal with the development of the earliest chapbooks, primers, and the development of clothbound and paperback book materials. A few courses introduce students to the idea that audio books are available today for nonreaders or for those who like to listen to stories. What is missing from journal articles and discussions of children's or adolescent literature courses is information about the newest form of book which is gaining wide acceptance by youngsters—the electronic book. It is time to ensure that preservice teachers learn about electronic books, since parents are now buying them for their children and some schools are starting collections for use at both the elementary and secondary school levels.

In the past few years, largely because of the enthusiasm generated by Mercer Mayer's fun and attractive interactive electronic book entitled *Just Grandma and Me*, (Broderbund) many individuals and publishers have begun to use the CD–ROM (compact disc–read only memory) format to package both original and repurposed (formerly published on paper) titles. In fact, in just the last year there has been an explosion of children's electronic books as reported in catalogs and journals such as TigerSoftware whose fall, 1993, catalog lists page after page of CD–ROM titles.

A CD–ROM is capable of holding a great deal of information which can be quickly accessed—particularly on the newest triple-speed or quadra-speed CD–ROM players. The CD–ROM format is ideal for engaging youngsters in reading and interacting with both fictional stories and nonfiction information. For nonfictional materials such as Compton's *Interactive Encyclopedia*, *Mavis Beacon Teaches Typing*, materials which deal with chess, animals, history, medicine, Shakespeare, etc., vast amounts of photographs, illustrations, animations, videos (both *Quicktime* as well as full motion), and sounds aid in the presentation of information. For fictional CD–ROMs such as *Beauty and the Beast*, *Peter and the Wolf*, *Mowgli's Brothers*, and *The White Horse Child*, stories are presented, usually with accompanying narration, in ways which take advantage of all of the capabilities of multitimedia technology. Last year, as I was preparing to teach a section of children's literature, I analyzed a variety of CD–ROM electronic books. As a result of that investigation I noted that many have common basic features of appearance, narration, and the kinds of activities users can engage in while interacting with the CD–ROM. The following section lists these features:

Appearance

1. Some "pages" in CD–ROM books look very much like pages in a printed book. Discis books, for instance, have what look like diaphanous pages which appear to flip over to reveal the next page. Some companies pages, however, simply look like computer screens full of print.

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2. The reader usually "turns a page" by clicking a mouse on an icon on the corner of the page or on a marked button.
3. Most stories are illustrated, but the quality of the illustrations varies greatly. In some instances, the illustrations contribute to the story (e.g., in *Just Grandma and Me* the illustrations contain "hot spots" (hidden buttons) which, when clicked, start the animation sequences). In other cases, the illustrations are mere decorations and, in some cases, the same illustration remains on the screen throughout several pages of text.
4. Some stories have text on top of the illustrations. Some wrap the text around the illustrations, and some have illustrations on "facing pages."
5. Often the text is highlighted while it is being read by the narrator. In some programs it is possible to adjust the highlighting so that individual words or single lines of print are highlighted. In other cases, some programs enable users to highlight entire sentences as they are read by the narrator.

Narration

1. For the most part, the narration can be turned on and off as the user desires.
2. Both males and females are used to narrate the stories.
3. Professional actors/narrators seem to be used most frequently, but children are used appropriately in some stories.
3. For most programs the volume can be adjusted within certain limits. Since many multimedia machines include headsets as part of the equipment, this is an important feature for individual users.
4. All of the CD-ROMS examined contained English narration. Some also included the option to hear (and/or read) the story in Spanish, French, or Japanese.

Activities

1. In some programs readers can click on words in order to have them spoken by the narrator.
2. In other programs, readers can click on words to hear the words pronounced in syllables.
3. In many stories, readers can click on words and have them defined and/or used in sentences by the narrator.
4. Often readers click on objects to hear sound effects or see animated sequences.
5. In many materials, readers can click on various icons to find information related to the story itself or information about related subjects which are mentioned in the stories.
6. Some CD-ROMs contain comprehension questions about the stories. These questions are similar to end-of-chapter questions found in many textbooks.
7. Sometimes the words which students clicked on in order to hear them pronounced (or to hear their definitions) appear in a word list which a teacher can inspect in order to diagnose a student's word recognition problems.

It is important to preservice teachers to examine a number of children's or adolescent literature CD-ROMs in terms of the basic features described above.

There are several important issues which users of these products need to address if they wish to use CD-ROM materials in their classrooms for instruction. First, the matter of illustrations needs to be addressed. Typically, illustrations form an integral part of stories, revealing information in ways which help readers comprehend the story. In those CD-ROMs where decorative art is "thrown in" for the purpose of adding color and little else, criticism should be leveled at the publishers. Second, the highlighting of individual words may contribute to word-by-word reading—a habit that most teachers work hard to help students overcome. Additionally, the highlighting of lines of print regardless of meaning units is not justified. Phrases, clauses, or complete sentences are the basic thought units, and highlighting of these units is more appropriate than highlighting words or lines of print. Third, rate of presentation is not addressed in any of the stories examined. For very fast or very slow readers no adjustment of speed is possible. Fourth, it is difficult to see the need to have words pronounced in syllables, since this is typically a part of word attack instruction not recreational reading. Fifth, the quality of comprehension questions, typically literal level instead of inferential level questions, needs to be upgraded dramatically if such questions are to be included in CD-ROM materials. Finally, there is a big issue to be investigated about what students actually learn as a result of interacting with CD-ROM electronic books. In some cases, there are few words on a page but dozens of things to click on. In these instances what is the student learning about reading? In other cases, the CD-ROM looks as if page after page of text (and a few graphics) had been put on the disc for no other purpose than to sell the story in the new electronic format. One CD-ROM had twenty chapters of a well-known story and little else on the disc. All of these issues deserve discussion in college and university literature courses.

Assessing CD-ROM Electronic Storybooks

In addition to the questions just raised, there are other features of CD-ROM electronic books which should be discussed and assessed by prospective teachers. They are:

1. Is narration clear, pleasant, and appropriate with publishers using different voices across stories?
2. When words are highlighted, does this cause a jumpy appearance to the text?
3. Can the story be read in languages other than English?
4. Are there multicultural images in the materials?
5. Is the text readable? Black electronic print on a red background, for instance, is very difficult to read.
6. Is the artwork the same as it appeared in the original printed book?
7. Is the art appropriate to the story if it is newly created for this remake of a print version?
8. Is animation simply entertainment or is it instructional?
9. Are there appropriate sound effects?
10. Are there too many things for students to click on? Too few?

11. Are there "bookmarks" and "go to" buttons that help readers quickly move to a specific place in the book?
12. Are there on–screen activities, teaching hints, test items, background information, etc. to aid teaching and learning?
13. Is the program "user friendly" so students can get in and out of areas of the program easily?
14. Will the CD–ROM run at an acceptable speed of response on most CD–ROM players?

Most of today's professors of children's and adolescent literature grew up in the age of hardback and paperback books. Many are having difficulty accepting electronic books as suitable materials, even though children and older students are being exposed to them in many schools today. Comments such as, "I can't snuggle up in bed with an electronic book!," and "These are just another fad that will go away," are not uncommon statements uttered in literature classes. Judging from their popularity, however, it is unlikely that electronic books will disappear. It is, in fact, more likely that books printed on paper will become scarce as the cost of making them continues to escalate and our forests disappear.

Judging from the explosion of CD–ROM electronic books which have become available in the last year, it is clear that both former popular books and newly–created interactive books with clever features will be used widely in K–12 schools in the next decade. Colleges of education, therefore, must take leadership in assessing these new materials, helping the industry set high standards for their use in educational settings, and educating teachers about them. In addition, educators need to take leadership in conducting research to determine just what students learn as a result of interacting with electronic print and story materials. The study of CD–ROM electronic books should keep professors of literature, reading, and specific content area subjects greatly occupied in the coming years.

(Note: With the exception of *Just Grandma and Me*, the CD–ROM titles mentioned in this paper are listed in the *TigerSoftware*, *2*(11), Fall, 1993, catalog.)

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MATHEMATICS

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The shift in recent years from the behavioral approach in the 1970s and 1980s to the approach that teachers and students need to construct their own knowledge base about the use of technology can easily be seen in the area of mathematics. Learning how to learn with technology, specifically learning how to learn mathematics with technology, is the theme of the articles in this section.

In recent years, the National Council of Teachers of Mathematics (NCTM) has recommended standards for both the substance and delivery of the K-12 mathematics curriculum. Each of the articles in this section focuses on these standards directly or indirectly. The articles are divided into two basic areas: the use of computers and the use of calculators in the teaching of mathematics. In each case, the predominate proposition is that teachers as well as students must take a constructivist approach to mathematics.

To begin this section, Troutman, Dickinson and Austin discuss a teacher profile established by the NCTM and how this profile can be used to establish a conceptual map to classify research questions on the preparation of elementary teachers. This five-dimensional map encompasses mathematical competence, teaching competence, knowledge products, knowledge process, and media knowledge. This exploratory paper represents a desire to examine and share research questions bridging the gap between the goals for proficiency of elementary teachers and actual practice.

Teyah and Pokay explore an array of alternative assessment measures and their impact on using various technologies to teach mathematics. Open-ended questions, projects, performance assessments, self and peer evaluations, observations, interviews and portfolios have the potential to better reflect what children know about mathematics and provide superior information for making sound instructional decisions. The effort to integrate technology and alternative assessment for preservice educators is developed through the use of a geometry program, the *Geometric Sketchpad*, which allows students to make conjectures and create geometry. One major advantage of using this computer program is that preservice educators begin to see how problem-solving skills develop.

Hunter's article, *Math Teacher as an Author: Strategies for Developing Successful Classroom CAI*, considers the instructional strategies used in creating quality courseware and how these techniques can be developed and implemented by secondary mathematics teachers in their own classroom applications. Bowers, Barron and Goldman look at the multimedia capability of HyperCard to develop a teacher education simulation. This simulation permits preservice teachers using a videodisc controlled by the HyperCard stack to investigate critical issues found in actual mathematics and science lessons.

Beers and Orzech discuss the implementation of information technology in all aspects of teacher training. The primary focus of this study was the implementation of an elementary mathematics methods course. Using the successful model developed in this initial course, a model classrooms and methods courses in other disciplines will be phased into the preservice schedule.

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The articles by Taplin and James and Glidden, both discuss the inadequate mathematical skills of preservice educators. In the Taplin and James article, a computer-assisted tutorial using a HyperCard stack was developed. The pedagogical aspects of designing this system are the focus of this paper. Glidden used *Mathematica*, mathematical programming software, and calculus to open a new realm of mathematical ideas for preservice educators.

Recently, North Carolina has mandated one credit of algebra as a requirement for high school graduation. This has fostered two different studies — one observing the use of problem-solving computer software and graphing calculators in group problem-solving and the other attitudes of teachers and using calculators. McCoy developed a workshop, in the constructivist tradition, using the appropriate technological tool to establish connections between algebra and real problems. Bowman and Bright report the impact of two calculator projects on teacher attitudes, teacher instructional practices and the evolving concern about teaching mathematics with calculators.

Similar to the Bowman and Bright study, Fleener investigated the response of Oklahoma middle school and secondary mathematics teachers to determine their attitude concerning using calculators in teaching and learning mathematics. She also studied the differences between those who had mastered calculator use and those still in the learning cycle.

Kraus discusses the integration of computers and calculators into the preservice mathematics education program at Wittenburg University. He feels that his modeling of the use of calculators and computers in the mathematics course for preservice educators will give an added dimension to the use of technology for these novice teachers.

Bauder, Planow and Sarner discuss the development of Project TIME, an attempt to alter mathematics instructional strategies at all educational levels by supplying the technological and pedagogical skills, enhancing self-confidence, and to developing a peer support network. An important component of this program was its early reliance on teachers to participate in the design, scheduling, budgeting and participant selection.

Zambo describes an attempt at reforming one high school district's mathematics curriculum. A primary facet of this implementation was an intensive summer Pre-algebra Academy for incoming ninth graders to prepare them, instead, for Algebra. The calculator played a prominent role in both the Academy and the other aspects of pedagogical reform. The study includes teacher attitudes toward calculators prior to and following the academy project.

Similar to the approach used in Project TIME, Williams, Bright, Kenelly and Harvey found that teacher involvement in the planning and development of an innovation is a significant factor in the innovation's implementation. Teaching Mathematics with Calculators (TMC), a project to assist teachers in grades 6-12 to use calculators in teaching mathematics, developed a summer institute, video tapes and printed material as the core of a workshop for teachers to use in any school. This study investigates the effect of both teacher involvement and the teacher leadership role in the training of other teachers.

Nath, Williams, and Waxman look at the effects of calculator confidence and student belonging on student mathematical problem-solving skills achievement in a multiethnic school district. Since this district had received a three-year Department of Education grant to develop mathematics curricula incorporating the use of calculators, it was a fertile ground to investigate how students seek to learn in social ways with technology. Both pre- and inservice mathematics educators should be aware of the consequences of technology use on students' affective outcomes.

Is there a relationship between student perceived calculator confidence and problem-solving achievement? Is there a relationship between student mathematics anxiety and the stages of student problem-solving achievement? The study reported by Williams, Nath and Waxman measure calculator confidence, mathematics anxiety, and problem-solving achievement to determine the relations between cognitive and affective outcomes.

Finally, Williams, Waxman, Copley, Huang, Nath, and Bright summarize three studies that were designed to identify the implementation process with varying initial attitudes toward calculators, among groups with varying responsibilities in the curriculum development process between experienced and novice teachers and between coached and non-coached teachers.

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A Conceptual Map for Classifying Computer Related Research Questions Concerning Proficient Teaching of Elementary School Mathematics

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In recent years the National Council of Teachers of Mathematics (NCTM) has made strong recommendations calling for reform in both the substance and the delivery of the mathematics curriculum K-12. These recommendations place heavy responsibilities on those who prepare teachers. The vision of the ideal mathematics classroom projected is one in which students and teachers collegially engage in the teaching/learning process. The teacher's role is to design learning environments in which he or she guides instruction while students continuously construct and refine their own knowledge. Problem solving and mathematical reasoning are the driving forces, and students learn in safe environments in which mathematical inquiry and debate is the norm. Learning experiences extend to the personal real world of the student and to the macrocosms of business, science, and industry while the learning environment mirrors the best that instructional technology has to offer. As most educators recognize, preparing teachers with the mathematical knowledge, pedagogical insights, and appropriate attitudes to create instructional environments that manifest this vision will take considerably more than the specification and acceptance of recommendations.

Teacher Profile Implied by the NCTM Standards

Teachers must have a comprehensive definition of mathematics and considerable content knowledge that extends beyond abilities to cite rules, definitions, and complete procedures. They must have conceptual knowledge that allows them to translate, rearrange, interpret, connect, represent, and communicate mathematical ideas with clarity. Above all, they must be good problem solvers, able to distinguish between routine problems that require low levels of translation and authentic problems that require the creation of unique solution strategies. Teachers must also possess metacognitive skills that allow them to consciously regulate their cognitive processing of mathematical information (e.g., "I know that I can look for a pattern;" or "This problem needs to be broken down into smaller parts."). In short, teachers must have pedagogical content knowledge as well as knowledge of: (1) subject matter suitable for instruction, (2) how students' learn mathematics, (3) state-of-the-art media needed for delivering instruction, (4) instructional design techniques, and (5) methods of assessment. Teachers must have confidence in their abilities to do mathematics and positive attitudes toward mathematics and the use of technology.

Teacher Profile Emerging from the Professional Literature

The elementary teacher sees mathematics as a fixed body of knowledge, linearly organized, from which he or she must memorize and repeat procedures to obtain answers. Most feel their competence is limited by innate ability. They approach mathematics as adult learners with personal agendas perceiving that others possess some understanding that they lack. Confounded by a view that teaching mathematics is a matter of technical competence, they fear exposure of their perceived deficiency and avoid non-routine problem-solving situations over which they do not experience control. They carry out the teaching role by breaking down concepts, facts, and skills into small pieces and providing practice on each piece. Significant tension exists between their vision of themselves as teachers and their own teaching practice, so they often implement a teaching pattern imposed by text materials based on goals defined by an outside authority. Generally, they have not been predisposed to working cooperatively and to relying on peers, so they adopt a teaching/learning model in which the teacher is the final authority. (Sandra K. Wilcox, Perry Lanier, Pamela Schram, Glenda Lappan., 1991)

Filling the Wide Expanse

The challenge that teacher educators face is monumental. Any significant change will first require the articulation of instructional research questions for which answers have a reasonable chance of increasing the congruence between the ideal teacher profile and the real teacher profile. Second, considering the resources available to educators and the capabilities of technology, it is important to integrate the power of technology into both the study and delivery of promising practices. Third, since there are so many research questions concerning mathematical content, pedagogical content, and beliefs and attitudes that need to be articulated, it appears logical and extremely important to develop a coherent map of the academic domain's content, the knowledge and skills required to teach domain content to, in this instance, elementary students. Such a conceptual map, as a hueristic, permits the organization of research questions that help researchers find their way through the maze. The components of the map would be structurally complex, and each component might intersect with others in various places. Essentially, the map could be represented by a multidimensional search space in which each dimension is composed of somewhat discrete classes, each class characterizing a quality of some aspect of knowing, using, justifying, controlling the use of, or teaching mathematical knowledge. In this paper we will propose such a model and identify questions that can be located in the model's search space that are related to estimation and problem solving — two emphases of the NCTM Standards.

A Conceptual Map for Proficiency of Teaching Elementary School Mathematics (PTEM Map)

The following conceptual map for studying the preparation of elementary teachers is offered as a starting point for characterizing and locating research questions germane to the teaching of elementary school mathematics. The main motivation for its development is to provide a vehicle for classifying appropriate research studies in this area, communicating about this research, and logging progress. The map currently is defined to be five-dimensional with the dimensions labeled as follows: (1) mathematical competence, (2) teaching competence, (3) knowledge products, (4) knowledge processes, and (5) media knowledge.

Mathematical Competence encompasses those qualities that ensure one's ability to know and to perform mathematically. This dimension subsumes the following classes: (1) has conceptual knowledge; (2) can perform mathematically; (3) can describe and justify mathematical processes; (4) can maintain a control system that regulates and controls mathematical processing.

Teaching Competence encompasses those qualities that ensure one's ability to teach mathematics. This dimension subsumes classes that characterize mathematical content pedagogy. The classes identified are (1) knows what conceptual knowledge to teach; (2) can effectively teach conceptual knowledge; (3) can teach students to perform mathematically; (4) can teach students to describe and justify mathematical processes; (5) can teach students to regulate and control mathematical processing.

Knowledge Products encompasses the knowledge domain considered relevant for the teaching of elementary school mathematics. A possible way to define this dimension is to use those areas postulated in the NCTM Standards for K-4 & 5-8 (NCTM, 1989): These would include (1) number sense and numeration; (2) concepts of whole number operations; (3) computation and estimation; (4) geometry and spatial sense; (5) measurement; (6) probability and statistics; (7) patterns and relationships; and (8) algebra.

Knowledge Processes encompass mathematical processing skills subsuming the following classes: (1) can retrieve; (2) can transform or represent; (3) can interpret or connect; (4) can apply; (5) can analyze and synthesize; and (6) can evaluate.

Media Knowledge encompasses knowledge related to the personal or instructional use of media for transmitting or transforming knowledge: (1) can productively use non-interactive media; (2) can productively use interactive media; (3) can organize productive learning experiences with non-interactive media; (4) can organize productive learning experiences with interactive media.

Research Questions for Estimation

The ability to estimate rather than to compute an exact answer with pencil and paper is considered to be a primary part of an individual's mathematical development (NCTM, 1989, NCSM, 1989.). Yet existing research evidence indicates that prospective elementary teachers are limited in their ability to estimate (Gliner, 1991). In Gliner's study performance on estimation exercises involving rational numbers in fractional or decimal form was poor; careful analysis of performance on individual items would lead one to suspect that difficulties reside not in inabilities to estimate but rather in a general lack of number sense. These results are consistent with the authors' observations resulting from two decades of instructing prospective elementary school teachers.

Since the NCTM Standards recommend acquisition of estimation and number sense skills that far exceed the skills demonstrated in Gliner's study, it is clear that improved methods are needed that will help teachers acquire better skills. Since it is also argued that educators should harness the technological power to help overcome problems of delivering effective instruction, it seems fitting to find methods supported by technology. Given that resources for educational research are extremely limited, it makes sense to ask productive questions and encourage cooperation among educational researchers. To ask productive research questions related to estimating and to communicate effectively, we need a language or map such as the proposed PTEM Map. By subjecting each research question to analysis using the map, we can determine the major emphases of the question. We can also determine what is not emphasized and how the question might be limited. The ability to classify research questions in this way could provide a tool for comparing studies and planning collaborations. Using the conceptual map to create and structure further research questions and to classify research already completed can reveal gaps in the current research status with regard to teaching elementary school mathematics.

Each of the following questions is related to the instruction of estimation skills and could be explored in relationship to computer-dependent research or instruction. Each can be classified in terms of the PTEM Map to determine major emphases. To demonstrate the PTEM Map's use, we classify some questions and provide related discussion.

Question: What relationship exists between the ability to match computer-generated equivalent representations for rational numbers and the ability to estimate, in a computer controlled environment, sums, differences, products, and quotients of numbers in decimal or fractional form?

Classification: Mathematical Competence — has conceptual knowledge; Knowledge Products — number sense and estimation; Knowledge Processes — can interpret or connect; Media Knowledge — can productively use interactive media.

Discussion: By using the map we can determine initial specifications for a study. We can decide whether variables should be eliminated, other ones should be included, and how the research questions might be refined, subdivided or extended. We also have a tool for writing parallel questions that may involve other aspects of the map — in this case perhaps parallel questions for the dimension of Teaching Competence.

Question: Does greater ability to numerically represent computer-generated models for numbers facilitate one's ability to formulate and explain algorithms for estimating? Is the ability to find number representation for computer-generated models such as the following related to the ability to choose and explain estimation algorithms?

Classification: Mathematical Competence — has conceptual knowledge, can perform mathematically, can describe and justify; Knowledge Products — number sense and estimation; Knowledge Processes -- can analyze and synthesize, can interpret and connect, can transform or represent; Media Knowledge — can productively use interactive media.

Other Questions: What effect would computer-based instruction in which respondents match a variety of models for rational numbers have on the acquisition of estimation skills? Does greater ability to manipulate models for numbers facilitate one's ability to use a variety of estimation techniques — on the computer, in real-life, etc?

What relationship exists between the ability to mentally determine the order relation for two or more rational numbers such as 2/8 and 2/7 and the ability to tell whether sums, differences, products, or quotients involving these number pairs are greater than, less than, or equal to 1. What effect does instruction on matching these number pairs to appropriate graphical models or to informal justification concerning the relationships have on the ability to estimate?

What is the relationship between the ability to mentally compute exact sums, differences, products, and quotients with fractions and decimals and the ability to estimate with fractions and decimals?

What effect does a variety of types of immediate computer feedback, given in a variety of ways — audio, graphic, textual — have on achievement of estimation skills?

What is the relationship between the ability to discriminate correct and incorrect computerized graphical models for rational numbers and the ability to estimate? What effect would instruction on recognizing correct and incorrect graphical models with feedback for decimals and fractions have on the ability to estimate?

What effects would computerized "say-along practice" have on the ability to estimate? What effects would computer practice with highlighted text and audio cues that provoke reflections on number rounding or on necessary arithmetic operations have on estimation performance? What effect does practice with "hot buttons giving explanations or pictures" have on the ability to estimate?

What effect does learning (practicing) estimation via a computer program have on personal assessment of control or success? What advantages over traditional delivery systems does using computer instruction afford, e.g., time, immediate feedback, instructional support, and self-help for students?

These are just a few questions — not intended to be exhaustive — that, once classified according to the map, could provide comprehensive guidance to researchers for studying and teaching proficiency in estimation.

Research Questions for Solving Verbal Problems

A broadly stated problem-solving standard is the first standard listed in the NCTM Standards and is well accepted by mathematics educators. While the concept of problem solving calls for far more than translating a word problem into a number sentence, directly applying algorithms, and then computing solutions, these skills are necessary for problem-solving proficiency. Generally, these types of problems are classified as translation type exercises in which the learner connects verbal problems to number sentences to algorithms to computations to solutions. We will focus here on these types of verbal problems since they are fundamental to the elementary school curriculum. Several interpretations for each of the basic arithmetic

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operations are found in textbooks designed for mathematics methods courses (Troutman and Lichtenberg, 1991), and mathematics content courses for elementary teachers (Billstein, Libeskind and Lott, 1990). For example the whole number operation of subtraction involves several interpretations — take-away, comparison, missing addend, partition — depending on the context of the problem. Problems for each of the interpretations may not appear on the surface to be similar, yet, all require the operation of subtraction for effectively finding solutions. Thus it is important for teachers to be able to recognize and fluently pose problems for each of the interpretations for each of the whole number operations. A framework for these interpretations can be refined from existing sources and used as a basis for studying these abilities. Fluency refers to the ability to write sets of word problems using numbers, interpretations, operations, appropriate vocabulary, and context interesting to the target grade level of school children. A literature search found no studies focusing on these abilities. The research questions considered here could identify what prospective elementary teachers already know about verbal problems and problem posing and could indicate promising strategies for increasing their proficiency. Here are a set of questions germane to this topic, two of which have been classified by the PTEM Map.

Questions: Will prospective elementary teachers, without specific instruction, classify a set of word problems according to different interpretations of the basic operations? What effect will feedback with regard to their ability to classify problems according to the interpretations have on future ability to classify problems?

Can prospective elementary teachers, without specific instructions, fluently pose a range of verbal problems that adequately represent the possible range for each operation? What effect will feedback regarding their ability to fluently pose problems for the interpretations have on future ability to fluently pose verbal problems? How can fluency be measured?

Since the number of contact hours in method courses is not sufficient to cover all essentials, is it possible to mediate this instructional dilemma using computer-based instruction out of class?

Question: What effect will building a large data base containing problems reflecting the interpretations for all four operations have on the ability to recognize and fluently pose verbal problems reflecting the interpretations for the four arithmetic operations?

Question: What effect will examining each problem in and adding classification codes to each record of a large data base containing problems reflecting the interpretations for all four operations have on the ability to recognize and fluently pose verbal problems reflecting the interpretations for the four arithmetic operations?

Classification: Mathematical Competence — has conceptual knowledge; Teaching Competence — knows what conceptual knowledge to teach; — Knowledge Products — concepts of whole number operations; Knowledge Processes — can interpret and connect; Media Knowledge — can productively use interactive media.

Discussion: As you can see both questions attack the same components of the map, so it makes sense to ask which of these might lead to higher fluency rates for posing problems. Other ideas to consider in relationship to these questions relate to whether the activity occurs outside of class, individually, or in cooperative groups.

Creating a Context for Sharing of Research Efforts and Findings

The purpose of this paper is exploratory, the map has not had extensive testing and certainly the questions are very limited. This paper represents a desire on the part of the authors to examine and share research questions, the answers to which could mitigate the existing chasm between goals for proficient elementary school teaching and actual practice. More importantly it proposes a tentative conceptual map for examining such questions in the light of what we currently know about knowledge, teaching, learning, and technology. We enthusiastically invite collaboration and constructive evaluation.

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The New Mathematics Classroom: Integrating Technology and Alternative Assessments

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Traditionally, college mathematics courses have rarely integrated technology or alternative assessments in the teaching/learning process. Instead, they have relied on textbook exercises and problem sets in a lecture or recitation format. The National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* (1989) have spurred on a reform movement that calls for both curricular and instructional practices to shift more emphasis to the use of technology, open-ended problems, and written and oral communication with evaluation as an integral part of teaching and improving instruction. In addition, the NCTM Standards have encouraged curricular changes that integrate technology with mathematics learning, deleting topics that have become irrelevant in the light of technology.

Thus, technology is impacting what we teach and the way we teach in the mathematics classroom. The use of computer applications focusing on real life problems and allowing students to experiment has opened the door to a wealth of problems that were not previously feasible. However, there remains a gap between the potential of the technology and the realities of the mathematics classroom. One way of closing this gap is to focus on the college environment where future teachers are being trained. If change is to occur, courses designed for preservice teachers need to model how technology can be used to teach mathematics, examine the impact of technology on the K - 12 mathematics curriculum and use technology as a unique tool for learning mathematics. Preservice teachers need to experience how their own understandings of mathematical concepts are enhanced as a direct result of technology.

The inability of past assessment measures to genuinely reflect student understanding of mathematical concepts and procedures, has led to a push toward alternative assessments in mathematics including open-ended questions, projects, self and peer evaluation, performance assessment, observation, interviews and portfolios (Clarke, Clarke, & Lovitt, 1990; Stenmark, 1989). These alternative forms of assessment have the potential to better assess what children know and provide information for making instructional decisions. As mathematics teachers work to redefine their classroom with technology, assessment has the potential to serve as a valuable tool in curricular decisions involving this technology.

Implementing the NCTM Standards will require that teachers be receptive to alternative approaches in teaching, specifically the use of technology, and assessment of student learning. While the reform movement in mathematics education focuses on K-12 mathematics learning and teaching, the education of preservice teachers affords an ideal place for intervention. If future teachers are to implement these recommendations in K-12 classrooms, they first need to see these practices modeled during their training.

In this paper we will describe our efforts to integrate technology and alternative assessments in a college mathematics course for preservice teachers. We will describe the course and students, then explain the procedures we used to integrate computers and alternative assessments into the classroom. Finally, we will reflect on our successes and problems and provide suggestions for future implementation.

Course and Students

In order to explore innovations in mathematics, we chose a geometry class for elementary teachers majoring or minoring in mathematics. This particular class focused on informal geometry topics and how they can be taught in the elementary school. Whereas most courses in plane geometry rely heavily on the two column proof, the emphasis of instruction in this course was on group work and discovery. Students were to develop their own theories and discover connections among geometric concepts through exploration on the computer. The instructor overtly focused on (a) mathematics as a process, such as the ability to make generalizations, reason and problem solve; and (b) the importance of motivational factors, such as self confidence and perseverance. Procedures used in class included problem solving activities, open-ended problems and cooperative groups, both on and off the computer.

The students in this course were undergraduate preservice elementary teachers majoring or minoring in mathematics. Their entering computer skills varied, although the experiences of most students centered on word processing. In addition, their experience with alternative assessments were limited, especially in mathematics where most had experienced only traditional approaches to teaching and assessment.

Technology

Technology was integrated throughout the geometry course using the *Geometer's Sketchpad*, a geometry program that allows students to make conjectures and "create" geometry. Students use a toolbox to draw points, lines, and circles along with menus for basic constructions and transformations. Measures of angles, slopes, distance, area, and perimeter are computed automatically.. The *Geometer's Sketchpad* is dynamic in that constructions can be "dragged" and measures are updated for each new sketch. With dynamic geometry programs, like the *Geometer's Sketchpad*, students collect numerical evidence to develop an intuitive sense for a problem situation in order to make conjectures about the solution prior to any formal proof.

Over the course of a year, we experimented with a variety of formats. Initially, the computer was introduced as one of several teaching tools and was not a major focus of the course. Both the nature of the assignments and the time allotted to computer work changed over time. Originally, computer assignments were given in addition to the regular assignments with little effort made to link these two. Assignments consisted of exploratory activities and could take up to two or three weeks to complete. Originally, students were required to complete assignments on their own time during open lab hours when the instructor was available to respond to student questions.

This format was comfortable for an instructor who was experimenting for the first time with integrating technology, since there were a maximum of five or six students in the lab at a given time as opposed to a full class of over 30 students . However, it failed to address other issues related to the preparation of preservice teachers. First, students viewed the computer assignments as an "add on" to the class as opposed to an integral part of the instruction. In addition, the course failed to model to how technology can enhance learning in the mathematics classroom and support classroom instruction. Preservice teachers need to see models of technology integrated in their mathematics training if they are to teach using technology to its full potential.

In order to more fully integrate the computer into the course, during the second semester, assignments were altered and the time schedule was changed. Instead of the students completing assignments on their own time, one third of the actual class time was scheduled for the computer lab. The allotting of actual class time provided a clear message that the computer assignments were a high priority. In addition, the computer assignments were more closely aligned with the regular classroom instruction in that they asked students to explore the topic being discussed in class through the use of the computer either to explore a subject in more depth or from a different point of view. This integration of computer work with the course promoted discussions of the assignments during the regular class time whereas there was little time for the class to discuss the computer assignments previously. In addition, it provided a situation where the student could see the integration of technology being modeled by the teacher.

Alternative Assessments

As the course evolved and became more computer intensive, the use of assessments evolved, too. Originally, nontraditional activities involved reflection papers and journal entries in addition to the more traditional homework assignments. Reflection papers consisted of weekly essays in which the students wrote about what they learned and how they felt about the material for that week. Some students chose to summarize key ideas and other students discussed pertinent questions that they had with respect to the material. Journal entries were also written on a weekly basis. These were different from the open-ended free writing nature of the reflection papers in that the journal included responses to specific prompts. The prompts were often related to mathematics content (i.e., Explain why there are five and only five Platonic solids.) and to student attitudes (i.e., What have you accomplished in this class over the last two weeks that has made you most proud of yourself?).

In addition, students kept portfolios that were comprised of two parts. Part one consisted of a collection of student work , usually referred to as a working portfolio and included reflection papers, journal entries, homework and tests. Then, at the end of the course students were asked to use their working portfolio to develop an evaluation portfolio by analyzing their learning throughout the semester. In the evaluation portfolio, students were asked to select items which gave proof or evidence of (a) their problem solving ability, (b) their confidence in their mathematics ability, (c) their determination to stick with a problem, (d) their most valuable experience in the class, and (e) an activity in which writing helped them to learn. For each item selected, the student was to write a letter explaining why they chose this example.

While this technique helped the students to reflect on their own learning and provided the teacher with valuable insights into the effectiveness of teaching techniques and student learning, several problems arose. First, the amount of time required of the teacher to read and respond to student reflection papers and journal entries was excessive. Second, since the students were only asked to evaluate their portfolios at the end of the semester, they were afforded only one opportunity to reflect and tie together the content learned in the course. Finally, since students were asked to respond only at the end of the semester, they had no way of knowing what the expectations were for their responses and thus were uncomfortable with the process. This posed a significant problem. Ultimately, we want these teachers to carry out this technique in their own classes. Hence, it was important that they have a positive experience with the procedure.

In order to reduce the amount of reading and responding on the part of the teacher and yet provide students with more opportunities to reflect on their work, the format of the alternative assessments changed during the second semester. Instead of requiring reflection papers and journal entries every week and waiting until the end of the semester to ask students to reflect and tie together the course, we developed an alternative to the traditional portfolio approach. We identified more specific questions that we asked students to respond to at several points during the semester. These included (a) What have you accomplished that you are most proud of? (b) What is the most important thing you have learned so far? (c) What things can you do well? (d) What things are you still working on? (e) What has surprised you? (f) What have you discovered? and (g) If the computer were a real person, what would your relationship with it be like? Students organized their responses in a booklet format including a table of contents. In this way students were reflecting at varying points during the semester yet the teacher was not collecting essays and journals every week that she would need to respond to. In addition, questions were added that specifically addressed issues related to technology. Finally, a peer assessment piece was added. Each student read another student's folder and identified the strengths and weaknesses of the folder. Thus, instead of being asked to write weekly essays, keep journals and develop an end of the semester evaluation portfolio, students during the second semester were to asked to develop folders that included specific questions asking them to reflect on their learning at four times during the semester.

Interaction Between Technology and Alternative Assessments

Traditional assessment becomes an issue in a technology based mathematics classroom. In the typical mathematics classroom, students are asked to complete assignments and "show their work". This "showing of work" helps teachers to monitor student progress and assess difficulties. In a dynamic geometry program like the *Geometric Sketchpad*, this "work" is often lost in that the computer does not keep a record of the processes that students have gone through to arrive at their final product. Thus, instructors see the final product but often do not have a clear picture of the process. Alternative assessments including the use of writing and portfolios have the potential to provide information on the process, thus improving instruction and communication in a classroom using technology. In addition, looking at the process provides a "window" for viewing the way technology impacts the learning of mathematics , beliefs and attitudes about technology, and the way students reevaluate those beliefs over time. Finally, it provides information for instructional and curricular decisions about future integration of technology that better meet student needs.

In this study, writing was used as a vehicle for understanding the process students were using. In so doing, a picture emerged of how students' saw technology impacting learning and their beliefs about technology. What follows are a few examples of what was learned through student writings. For instance, the impact of technology on the learning process was evident in several ways. Some students reported using the computer as a tool to record and keep their thoughts focused on a particular problem. One student wrote, "the computer helps me think in a logical, organized way and helps me to visualize my ideas. If I'm distracted from a task, it keeps me from forgetting everything I just worked on". Thus, the computer was used as a tool to help students organize their thoughts.

In addition, the use of writing helped both students and the instructor see evidence of the impact of technology on students' growth mathematically. Mathematics instructors want to believe that the technology is impacting the way students learn mathematics. However it was only through the process of writing and reflecting that the students and teacher became aware of how exploration on the computer was changing the students' view of mathematics and themselves as problem solvers. One student wrote, "I've learned to play around with the computer and answer my own questions. Usually I'm the type of person who will stop until my question is answered and I'm sure that I am doing it right. With the computer, I've learned to play around and use my own intuition." It is the safe environment of the computer that affords students the opportunity to explore and practice their problem solving skills.

In addition, often the expectations of the teacher do not match the abilities and attitudes that the students bring to the classroom. Instructors who are technologically literate, often overlook the complexity of student feelings when they begin to use the computer for their classwork. At the beginning of the semester, students wrote comments like " I feel like the computer is laughing at me" and "I am getting extremely mad at the computer. It makes everything more complicated. I just want things to go smoothly between us and it blows everything out of proportion." It was interesting to observe that even when a student wrote a comment suggesting frustration such as "My only hope is that time will allow the computer and I to get along better or else I may be forced to kill it one day," the same student often expressed a conflicting comment, such as, "I am most proud of the way I have been working with the computer." Too often, we assume that students are as literate and comfortable in the use of technology as we are. Student feelings like the broad range cited above, however, influence their willingness to learn and take risks with the computer. These student responses need to be acknowledged and taken into account by the teacher.

In addition to providing information concerning student learning at any one point in time, the procedure used in this study also allowed the teacher to monitor learning and attitudes over time. For example, students were asked the question, " If the computer were a real person, what would your relationship with it be like?" at several points during the semester. One student began the semester by saying, "...It takes me a million tries before I ever figure anything out, if I ever do figure it out! I really don't feel like I'm learning a whole lot because once I get the right answer, it's usually by accident and I can't figure out how I got it! This is very frustrating for me!" In a later paper she reported," The computer is starting to become like an old friend. Although it took a while to get used to, I'm finally starting to warm up to it. I look forward to working with it now. It still challenges me, but now I am learning to deal with those problems." Another student began her relationship with the computer as, " ...We don't communicate very well. I don't have enough patience for him, and he doesn't give me enough information for us to work together. This person is getting in the way of my learning." Later she stated, "Every day when I sit down to work with him, I learn to become more comfortable with him and more confident in our relationship. I'm learning a lot from him, and he's making learning easier, faster, and more concrete." The growth in these students' comfort level with the computer is evident. However, if they had not been asked to write about their relationship to the computer, this change would not have been as evident to the teacher.

Just prior to submitting their folders during the second semester, students exchanged work, read what the other had written, and wrote comments to the author. The use of peer evaluations significantly opened lines of communication among students. As students reflected on their beliefs and attitudes toward the computer, there was something quite reassuring about reading what their classmates were thinking and feeling. The peer assessment was significant in that by reading someone else's writings, students realized that their frustrations, especially with the computer, were shared by others. In their peer evaluations, one student wrote to her classmate " I understand how you feel that the computer sometimes lets you down or doesn't always explain things simply, but try to be patient. I am learning that I must learn the computer's language in order to communicate with it better ". These evaluations gave students "permission" to acknowledge how they felt and allowed them to realize that frustration was not equated with failure.

Conclusions

In sum, this study explored issues related to technology and alternative assessments in the preparation of elementary mathematics teachers. The use of technology appears to be most effective as an instructional tool when it is integrated into the classroom rather than being used as an enrichment activity outside of class. When it is integrated, it not only enhances learning of geometry concepts but provides a model for how students can use computers in their own future classroom. In contrast, when the computer is not integrated, it is seen as an add on to the "real" mathematics learning taking place in the classroom. Making the computer an integral part of the course, requires the instructor to refocus learning objectives in order to merge technology with mathematics instruction. Finally, the use of dynamic geometry programs that are integrated into the classroom appear to place students in a exploratory environment that not only fosters problem solving but makes both technology and mathematics less threatening to the student.

Alternative assessments, such as writing, have the potential to improve learning and instruction in a mathematics classroom using technology. These procedures force students to reflect on the process and become aware of the skills necessary for solving problems in mathematics. These assessments can improve instruction through increased communication among students and between student and teacher. Writing affords the opportunity for the instructor and student to dialogue on issues or concerns that are raised in student writings. It is important that as the instructor reads student writings, she responds with meaningful comments. These comments can provide the opportunity for one on one student teacher interaction. It is through increased communication that the instructor becomes more aware of the student's thinking processes and attitudes.

Finally, preservice teachers are beginning to seriously reflect on how one goes about the business of doing mathematics. This is a necessary step in their preparation as teachers. In order to teach children to become problem solvers, they need to learn how problem solving skills develop. In addition, they need more experience with this form of learning than they have experienced in previous mathematics courses. The integrated use of the computer provides a problem solving environment for students while the use of writing provides an opportunity for reflection on the part of the student and a window on this process for the teacher.

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Math Teacher as Author: Strategies for Developing Successful Classroom CAI

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There is a generation of elementary and secondary students who have lost interest in mathematics and science. Consequently, there is a continuous call for innovative teaching strategies to recapture fascination with these disciplines. The Division of Behavioral Sciences and Education at the Pennsylvania State University-Harrisburg has undertaken a two-year grant project designed to answer, in part, this call. The project seeks to implement the power of CAI and multimedia within secondary mathematics programs in three Harrisburg-area school districts. Towards this end, one phase of the project will provide mathematics teachers with formal training in a popular CAI authoring system in order for them to develop, field-test, and implement their own CAI classroom applications.

The choice of instructional strategies and how they are used in a program are key in creating quality courseware (Nolan, 1984). In order for the teachers in the grant project to produce truly effective CAI programs, their authoring training cannot occur in a technical vacuum but must occur within the contexts of CAI design issues and mathematics education. Towards this end, the paper will first examine instructional strategies found in professionally developed CAI programs that may be applicable for teacher-developed programs. Next, the paper will look at cognitive and affective instructional factors that are unique to mathematics and have potential impact on the effectiveness of CAI. Finally, since math CAI programs usually follow one of the three approaches of drill-and-practice, tutorial, and problem solving/simulation, these will be considered throughout the discussion, along with the various math disciplines, such as algebra and geometry.

Professionally Developed Programs

CAI programs considered in this section include large-scale, multi-user courseware projects such as PLATO, smaller-scale, sophisticated software such as *Sensei Algebra* (Broderbund), and CAI with characteristics of both. Several key design features emerge from literature that can apply to CAI developed by teachers for their individual classrooms. These design features include built-in management techniques, sophisticated branching, user-friendliness, use of multimedia, high levels of interactivity, strong correlation with curriculum objectives, and the integration of higher-order thinking.

Built-in Management Techniques

Built-in management techniques in the CAI courseware range from the very comprehensive computer-managed instruction (CMI) to piecemeal CMI elements. Middle-school and high-school mathematics teachers have consistently reported concerns over administrative tasks required when using CAI; and teachers and students have reported satisfaction with CAI features that perform record keeping and reporting functions (e.g., Beyer, 1991; Guerrero & Swan, 1988). Some of the large-scale programs (e.g., Computer Curriculum Corporation's basic skills programs, Comprehensive Competencies Program, Corvus/Ideal) often have record keeping functions that maintain a performance history of each student, including lesson tracking, test scores, and performance times and trials. Further, some of the programs use this information to "call" the teacher at strategic points (Jensen, 1985) and to diagnose mastery and then prescribe individual lessons and levels for students. Although extensive record keeping is not necessary with a narrower CAI program focus, a data base should be used to store information about a student's progress that can later be analyzed for types of errors, curriculum placement, and lesson progress.

Performance reports, which can be generated from a data base, can serve several purposes for teachers and students. First, individual summary reports can provide individual profiles of low and high performance areas, skills mastered, and progress over time (cf. Guerrero & Swan, 1988). Second, reports can track class performance, which may be especially useful for grouping students and for communicating with parents. Finally, Clariana & Smith (1989) found that providing low-level math students with reports of their CAI progress improved their course completion rates and achievement over those students not receiving reports. Reports can serve as a tangible form of feedback and should be implemented if even to a limited degree.

Branching

CAI authors must determine how users will travel through a program. Price (1991) identifies four types of branching beyond a linear program flow. *Learner-directed branching* allows some learner control, which can be an important feature for math CAI success. Price writes, "One of the most important factors in learners' perceptions of a CAI program is the extent to which learners perceive they have control over the program." (p.139) Rubincam and Olivier (1985) found that when students in a CAI transformational geometry course were allowed to choose topic objectives and whether to have instruction or tests first, some students adopted a learner control strategy (e.g., test first, instruction later), outperforming students who did not. In the program *Sensei Algebra* (Broderbund) students can select the presentation method that best matches their learning style (Philips, 1993), which not only provides learner control but provides a better instructional fit. Learner control is especially important in tutorials and problem-solving because every student will not solve a problem the same way (Nolan, 1984). Learner-directed branching can be accommodated rather easily with menus, buttons, and other selection devices.

Review branching allows a user another look at the material that has already been covered, but with no variation. By contrast, *single-remediation branching* provides a new segment of material with a different approach, new examples, etc. In mathematics there would be many applications for review branching, since students often need to review formulas and processes rather than have new illustrations or approaches. Review branching is relatively simple to develop, but there are issues to be considered. One, decisions about when and where to return students for review require careful planning. For example, students who were interviewed after using the PLATO system were annoyed at being returned to the beginning of a review when failing one step (Guerrero & Swan, 1988). Two, programs with review branching are potentially boring and die without a developer's creative touch. Authors developing problem-solving tutorials should resist using review branching because of the fact that students need different approaches.

Multiple-remedial branching is considered the most powerful design option. User input determines the flow of the program, and there may be as many paths as there are possible responses from the students. Needless to say, this is a complex design that requires a lot of time to develop.. It also has some specific implications for mathematics. For example, when Sleeman and Smith (1981) implemented a computer-based modeling system for basic high-school algebra tasks, they found that both between and within low- and high-level groups students made different types of mal-rule errors. It took the researchers over two years to adequately program the computer to diagnose student mistakes. Sleeman (1984) later concluded, "...no matter how carefully an instructional designer plans a sequence of examples, he can never know all the intermediate steps and abstracted structures that a pupil will generate while solving an exercise." (p.18) Other studies (e.g., Davis, Jockusch & McKnight, 1978, cited in Sleeman; Lewis, 1980, cited in Sleeman) have found similar results with algebra and geometry. CAI developers should consider these findings when attempting to build remedial branchings that second-guess student errors or even types of errors.

User-friendliness

User-friendly features can include pleasing and consistent screen design, easy navigation, input devices, program escapes, bookmarks, different help options, security measures, and well-written documentation. Also, on-screen calculators are specifically recommended for math programs (e.g., Goode, 1988).

The aesthetics of screen design are beyond the scope of this paper, but authors should consider layout, use of color, and text characteristics in their programs (cf. Price, 1991). Features such as buttons and simple keystrokes facilitate navigation and do not distract from program content, especially if they look the same, appear in the same place, and operate consistently throughout a program. Since most secondary students have some keyboarding or typing experience, keyboards and mice are usually adequate input devices. However, when content dictates otherwise, joysticks, light pens, or touch screens might be necessary. For example, in *The Geometric Supposers* (Sunburst Communications) students design their own triangles and quadrilaterals. A review by Mathis and Hanfling (1986) suggests that even though the program performs scaling and uses random points, a joystick, mouse, or drafting pad would better facilitate portions of the program.

In a classroom situation, time and scheduling are frequent concerns. Providing escape options throughout a program or in key places helps students avoid the waste of time and the frustration caused by being stuck in instructional, review, or testing segments. Escapes may be particularly important when more of a computer-controlled program flow is used. Bookmarks help efficiency by marking where a student left off when the bell rang or when another student took a turn at the computer. It is best if bookmarks are saved when students quit the program. Drill programs are less likely to need bookmarks since their purpose is repetition.

User-friendly authoring systems have help menus and screens that provide information about commands, authoring features, etc. Often these are available to both the author and user so that a developer does not need to create them. However, *content* help options need to be built into a program by the author to give students hints, remind them of procedures and rules, or recommend specific segments for review. For example, a student struggling with an algebra task might ask for or be given an on-screen hint such as, "Collect all the Xs on the left side and the numbers on the right." (Sleeman, 1984)

Security measures and documentation are of less concern with teacher-developed programs, although password protection should be used when programs maintain record keeping capabilities (Goode, 1988). Documentation might take three forms: 1) procedural documentation for substitute teachers or team teaching; 2) content documentation that relates CAI objectives with curriculum, provides lesson plan suggestions, and gives any necessary background information; 3) student "quick reference" documentation where help screen are not adequate (e.g., Nolan, 1984). Teachers and students alike appreciate simple, easy-to-read manuals, although they appreciate even more programs that are readily operable without them!

Curriculum Objectives

"...Support materials that relate software to curriculum objectives positively affect the establishment of the computer as an instructional tool." (Rose & Klenow, 1983, p.33) Surveys of and interviews with high school and intermediate teachers found correlation between CAI courseware and district curriculum objectives to be a primary concern (Beyer, 1991; Guerrero and Swan, 1988). Teachers developing their own products have an advantage here because they can create CAI that corresponds step-by-step with their curricula. Whether the CAI is the instructor introducing new topics and concepts, the tutor reviewing strategies for problem solving, or the drill sergeant moving facts from short- to long-terms memory, the content includes just what the teacher says needs to be taught.

Multimedia/Interactivity

"...Short bleeps change pitch as each function is graphed...reinforcing the image of a cyclic sine curve..." (Steffini & Mathis, 1986) This along with countless other software review phrases, such as "Excellent color graphics" and "The animation brings the concept to life," express the power possessed by CAI over traditional classroom instruction. The use of sophisticated graphics, sound, and video clips can serve to motivate and maintain student interest, simulate events, and bring abstract concepts to life with powerful visual models (Goode, 1988; Mathis & Hanfling, 1986; Philips, 1993). Most drill-and-practice applications derive little instructional benefit from multimedia other than to make it more game-like.

Popular programs have a high degree of meaningful student interaction, as students tend to evaluate programs on the basis of interest and participation level (Signer, 1983). There are different means of eliciting user interaction, the most commonly used being personalized messages, questioning strategies, feedback, and performance exercises (e.g., Price, 1991). First, personalized messages can make the computer experience more friendly, but by themselves they are a low level of interactivity.

Second, questions can be used to involve the learner and/or to evaluate knowledge of instructional material. "By forcing the student to answer questions, the software can insure that students understand the problem, plan out the use of a strategy, solve the problem, and then verify the solution." (Nolan, 1984, p.76) CAI questioning strategies usually mimic those of traditional instruction (True-False, multiple choice, matching, short answer, and interpretive), with the more open-ended being more difficult to program for responses. Questions should be relevant to content and not inserted simply for token interaction.

Feedback can be instructive as well as rewarding, and feedback is best if it is specific to learner input. Drill programs will primarily use feedback for rewarding while practice and tutorial CAI should use both types. Feedback can help students understand what they have done and why it worked (Nolan, 1984). For example, after completing certain steps in a lengthy algorithm, students might receive feedback that reinforces the steps completed and cheers them on.

Finally, performance exercises, such as plotting graphs, drawing triangles and quadrilaterals, and solving proofs, make use of the computer's interactive and multimedia capabilities. Exercises can "come to life" with animation and sound — and may be worth the effort and time needed for authoring a problem-solving tutorial or simulation.

Higher-order Thinking

CAI can be used as a discovery learning tool in mathematics, especially when integrated with class lessons. Mathis and Hanfling (1986) write about *The Geometric Supposer*, "The software encourages, almost entices, teachers and students to pose and attempt to prove geometric hypotheses." (p.44) Nieminen, Carroll and Uguroglu (1987) reported that when the percentage of computer time on problem-solving and simulations is greater, CAI is more successful. Several intermediate-level programs require the higher-order skills of deductive thinking, patterning, problem solving and creative thinking (cf. Edwards, 1984). Integrating CAI with other methods to induce higher-order thinking will reduce authoring time and challenges.

Math-specific Instructional Factors

A small body of math-specific CAI studies is slowly accumulating and providing insight into factors that influence learners' success with CAI and CAI's success with math. These factors include gender, academic level, time spent with CAI, and personalized lessons.

Gender

The study of female math anxiety is not new. As one example, Kloosterman (1985) gave 124 algebra students measures of ability, math achievement, and learned helplessness and found that females were more "learned helpless" than males and that female learned helplessness was related to math achievement. With a pedagogical response to the female math anxiety phenomenon, Damarin (1988) looked at CAI models and gender issues and postulated that knowledge *about* math can affect knowledge *of* math. Consequently, organization of math concepts should be fluid so that learners can structure their knowledge according to their own cognitive structures. Because a computer is gender-blind, Damarin feels it could be useful in providing non-sexist materials and feedback. However, Collis (1987) found that high-school girls transferred math anxiety to computers!

At the elementary and intermediate levels, Hativa and Shorer (1989) found that boys gain more in practice CAI than girls and that the gap between them widens with increased grade levels. In Burns and Bozeman's (1981, cited in Hativa) meta-analysis of gender and CAI achievement, 10 studies showed that boys tended to gain more from CAI math instruction than traditional instruction, but girls did not show that trend. Regarding gender and attitude, Hativa (1989) found only one significant difference out of 27 options for liking a CAI drill-and-practice program: girls disliked the competition with classmates that the CAI work enforced. In general, however, girls preferred class arithmetic over CAI. This preference may be in part attributed to the male bias in the approach to both mathematics and CAI. Johnson & Johnson (1985) reported on their findings, "...The combination of cooperative learning and computer-assisted instruction has an especially positive impact on female students' attitudes toward computers..." (p.13)

Together, these studies imply that careful consideration of the differences between how males and females approach both math and CAI is called for. Transferring the same "male" organizational structure and approach to computer instruction may be self-defeating if CAI is to be used to help overcome gender bias in math.

Academic Level

CAI has been found effective with both low- and high-achieving populations of students over all grade levels, including college (e.g., DelForge & Clark, 1989; Guerrero & Swan, 1988; Reglin, 1989-90). High achievers seem to learn faster with CAI, sometimes widening the gap between them and low achievers (e.g., McCallister, Back, Seaman & Pevoto, 1988), but CAI has been demonstrated to be effective with low achievers too. This high achieving-low achieving dichotomy is particularly true for drill-and-practice programs; thus, it appears that drill-and-practice CAI may be best when targeted for a specific group other than average students (Moore, 1988). Developers might consider targeting drill-and-practice CAI to low or high achievers and reserving the "average" material for tutorial CAI. However, these implications should be interpreted loosely.

Time

Although there is little replication between the scant number of studies measuring the effects of time on CAI learning, what there is indicates that amount of time spent with CAI is a variable for success. In an evaluative study of the Resource Laboratory Program for CAI for middle-school Chapter I students, Roberts & Madhere (1990) found the following: scope of remediation was a factor in greater accuracy in math skill development; the greater the number of CAI sessions, the more extensive the scope of remediation; and skill development was correlated with performance on the Comprehensive Test of Basic Skills. McCallister, et al (1988), measured basic skills progress of adults enrolled in a job training program that used three types of CAI systems. Length of time with a system produced more differences in gains than the type of system. Specifically, subjects with 6 weeks of CAI performed much higher than those with 4 weeks of CAI time. Finally, sixth-grade students immersed in CAI (most of every 50-minute math period for seven months) showed significantly higher gains from 1983 to 1984 on the Iowa Test of Basic Skills mathematics raw scores (Ferrell, 1986). Such studies might influence the purposes set for CAI development, depending on the schedules set by individual teachers. Amount of time students will spend with CAI should be related to the expected level of content mastery. It should be noted that these studies reflected both drill-and-practice and tutorial CAI.

Personalized Lessons

On the basis of on the theoretical orientation that contextual properties in math instruction are important for novice problem-solvers, Ross Morrison, Anand and O'Dell (1987) studied the effect of personalized CAI word problems on fifth- and sixth- grade students. Instead of tailoring content to groups interests the computer was more personal and solicited individual biographical information from users to integrate into word problems. Students receiving this "personal" treatment showed significantly better results on measures of attitude, formula recognition, and transfer than did control subjects. The authors caution that grade level and novelty may have affected the findings, but a subsequent pilot study with undergraduate education majors enrolled in a statistics course showed that they were positive about word problems centered around a self-selected theme. Even though positive results can be achieved with paper-pencil versions, the computer makes personalizing content a simple procedure. Developers might capitalize on this capability!

Summary and Conclusions

"Artistic, sensitive, knowledgeable mathematics teachers must be involved in direct ways with the construction of effective computer-based mathematics instruction." (Hatfield, 1984, p.6) Equipping classroom teachers to produce their own small-scale CAI is a very direct way to involve them in the changing face of education. However, because CAI is more than traditional instruction via a computer, teachers must have an understanding of the instructional strategies that make effective CAI and of their implications for authoring mathematics programs. Management techniques, branching methods, user-friendly features, and multimedia and interactivity determine the facility and interest of a program. An integrated curriculum that requires higher-order thinking helps determine the instructional value of a program. Additional factors that can influence a math program's success are gender, academic levels, time, and personalized lesson materials.

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An Interactive Media Environment to Enhance Mathematics Teacher Education

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Educational software programs that are billed as "interactive" run the gamut from tutorials to more open-ended and realistic simulations and microworlds allowing the user to investigate various "What if..." questions in different environments. In the case of preservice teacher education, the environment of interest is the elementary or secondary classroom. While the unpredictability of human nature renders it impossible to simulate the exact behavior of students and teachers in a classroom situation, it is possible to view a video incident from a real classroom and ask, "What would you do in this situation if you were the teacher...?" To bring some of the realistic variables of a classroom setting into a mathematics methods course for preservice teachers, mathematics educators at Peabody College of Vanderbilt University have developed a series of computer-based activities using HyperCard to control a videodisc player. These programs permit preservice teachers to investigate various critical issues (or mini-cases) that arise during a given lesson (Goldman et al., 1993). The present paper focuses on the development and implementation of one such activity involving a sixth-grade lesson on the area of a circle.

Background

The area-of-a-circle lesson simulation is one component of a HyperCard-based multimedia program called the Peabody Professional Development School (Barron, 1993; Barron et al., 1992; Goldman et al., 1993). The architectural metaphor of the Peabody Professional Development School (PPDS) uses a floor plan of a hypothetical school for the opening or "home" card. Resources are organized into "rooms" and are accessed through icons such as file cabinets or flip charts in the rooms. Students "entering" the school sign in at the office (log onto the system) and tell why they are there (select an assignment or choose the "browse" mode). For example, in the Demonstration Classroom, prospective teachers can watch assigned elementary school mathematics and science lessons. (Edited versions of the lessons are contained on videodisc.) A file cabinet in the Demonstration Classroom contains additional resources for each lesson including written lesson plans, pupil materials such as tests or practice sheets, and information about the mathematics involved. A file cabinet in the Computer Lab contains a database of mathematics software that can be searched by grade or subject. A flip chart in the Conference Room enables preservice teachers to review demonstration lessons and access comments by participants in the lesson or comments by the methods course instructor or other personnel. A computer in the Library accesses several databases such as students' misconceptions about mathematics (Graeber, Boyer, & Johnson, 1991) and lesson plans stored on CD-ROM that are consistent with the Curriculum Standards published by the National Council of Teachers of Mathematics (MathFINDER, 1992). Most rooms also contain a computer icon that accesses PacerLink, a communications package enabling users to connect to the Internet via Vanderbilt's main computer system.

A distinguishing feature of the PPDS is the inclusion of several interactive components that enable users to take advantage of the multimedia capabilities of random access video segments and branching to other programs. The timeline module of the PPDS (Goldman, Barron, and Witherspoon, 1992) exploits this feature by providing an on-screen graphic of an entire lesson, any point of which is instantly accessible with a mouse click. This graphic representation consists of a sequentially labeled horizontal timeline, allowing the user to view pre-defined subsections of the lesson. As the video plays, the correspondence of the video to timeline is updated by a moving progress bar. This timeline card also includes an on-line note-taking feature. If the user wishes to comment on a section of video, a click on the notebook icon will halt the videodisc player while a notebook entry is created. The notebook entry contains the beginning and ending frames of the segment of interest along with the user's annotated comment. A completed notebook entry icon is inserted into the timeline indicating its position relative to the lesson. Since the viewer has logged onto the system, the course instructor can retrieve the notebooks of the students who have analyzed the lesson. The software also allows the user to create a stand-alone HyperCard presentation stack of the completed notebook entries. Students in the methods classes have used this feature to create multimedia class presentations.

Area Of A Circle Lesson

Recent research has shown that preservice teachers' learning can be enhanced when they are faced with situations that evoke doubt and/or surprise regarding their established beliefs about the teaching and learning of mathematics (Ball, Lampert & Rosenberg, 1993, National Council of Teachers of Mathematics Professional Standards, 1991). It is important that these situations appear realistic and meaningful as opposed to ersatz exercises. According to the proponents of situated cognition, exposing students to authentic activities enables them to recognize and resolve ill-defined problems (Brown, Collins, & Duguid, 1989). Our use of critical lesson incidents as mini-cases enable preservice teachers to see how several unforeseen problems can arise during a real lesson. To facilitate discussion between the preservice teacher groups, the HyperCard programs contain discussion questions designed to highlight teacher decision-making and to elicit different hypotheses regarding the nature of the classroom students' understandings. Once groups have discussed their answers to the questions, the simulation asks them to type in their responses for later analysis.

Given the fast pace and complex interactions that occur in actual classrooms, the use of integrated media technology can provide a common basis for communication as well as an environment that is more conducive to analysis. This is particularly advantageous when working with preservice teachers whose predominant frame of reference for interpreting what goes on in a classroom is heavily influenced by their own schooling experiences (Ball, 1990; Lortie, 1975). The area-of-a-circle simulation was developed to facilitate the study of classroom interactions involving pedagogical tensions and content issues that teachers face. This is accomplished by highlighting some of the critical incidents that occur in the lesson to tease out some of the preservice teachers' interpretations. Further, by asking groups of preservice teachers to consider what they would do if they were the teacher in the situation, conversations focusing on these tensions may confront and challenge their beliefs about what it means to know and teach mathematics. The assumption is that the technology will function as a catalyst for group discussion and is not intended to portray any "correct" methodologies.

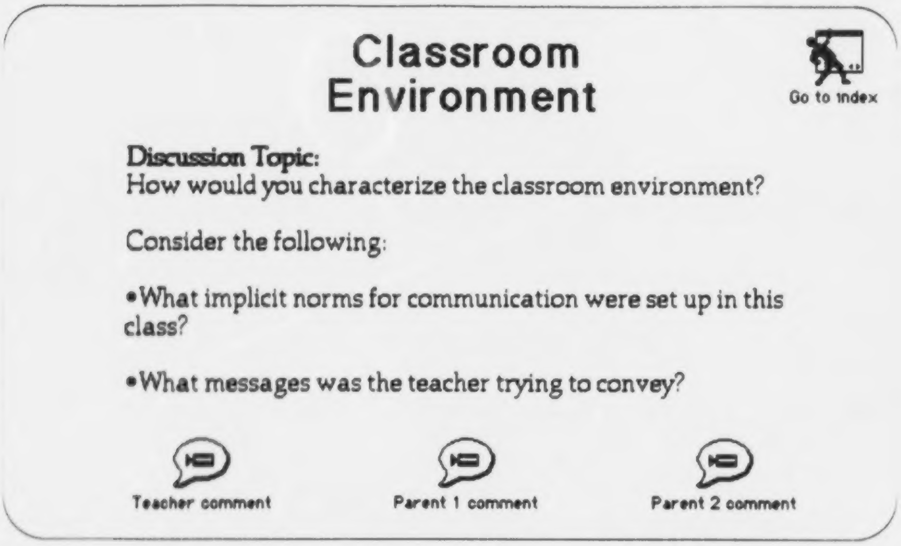
Pedagogical Stack

The area-of-a-circle lesson is divided into two separate stacks, one concentrating on pedagogical issues that arise during the lesson, and the other focusing on the mathematical content presented. The pedagogical stack presents multiple perspectives of this lesson to give preservice teachers an enhanced framework for interpreting different events. As the lesson progresses, various critical incidents occur in which teaching decisions must be made. At each of these points, the stack controlling the videodisc player stops the lesson and gives the users the opportunity to view prerecorded interviews featuring different participants' analyses of the incidents. For example, one recurring theme is the tension that teachers experience when they realize that some students are not fully understanding the lesson. Do they stop and review the material, or do they continue and hope that those confused will catch on? This tension builds when one considers the pressure of fully developing the concept (the area of circle formula in this case) in the time allotted. Videodisc-based interviews with the teacher, mathematics education professors, and classroom management specialists address this issue and give preservice teachers several perspectives on this tension.

A second theme that is highlighted in the pedagogical stack is the establishment of an atmosphere that is conducive to learning. The experienced teacher featured in this lesson makes a conscious attempt to involve all students and incorporate all opinions in the class discourse. The card illustrated in Figure 1 contains buttons accessing interviews with the teacher and parents that enable the preservice teachers to analyze how the teacher's efforts were viewed by the participants.

Content Stack

A second stack, also centered around the area-of-a-circle lesson, highlights some of the content issues that arise in the lesson. For example, the HyperCard stack controlling the videodisc player stops the lesson just after a student in the class makes the (incorrect) suggestion that the area formula for a parallelogram is the same as that for a rectangle (she suggests that the area of a parallelogram can be found by multiplying the lengths of adjacent sides). At this point in the simulation, the video is stopped and the preservice teachers are asked how they, as teachers, would handle this suggestion. (In analyzing videotapes of preservice teachers discussing this incident, a number of them have the same misconception.) After the users have typed in their responses, the videodisc then resumes and the actual classroom teacher's actions are viewed. Although the teacher



Classroom Environment

Discussion Topic:
How would you characterize the classroom environment?

Consider the following:

- What implicit norms for communication were set up in this class?
- What messages was the teacher trying to convey?

Figure 1. Card from pedagogy stack examining multiple perspectives of the classroom environment.

uses a series of examples to convince the students that parallelograms with same side lengths have different areas, some of the students in the class are still not convinced. The video stops again and the users are prompted to think of other ways they could help children discover that the area of a parallelogram depends on the altitude and not the slant height.

One of the new additions to this simulation is the ability to access the *Geometer's Sketchpad*. This software is a dynamic geometry micro-world that resembles a drawing program with construction tools. Users can construct and manipulate geometric figures to investigate and justify various propositions. Including *The Geometer's Sketchpad* in this simulation enables preservice teachers to explore why the formula for the area of a parallelogram is not the product of adjacent sides. As Figure 2 illustrates, this is done by animating a parallelogram to show how the area decreases as its altitude decreases even if the corresponding side lengths remain the same. This animation recreates what the sixth-grade teacher sketched on the chalkboard to "show" that the area formula of a general parallelogram is not the same as that for a rectangle. The portrayal of the parallelogram as "blowing over in the wind" refers to the teacher's description of how a parallelogram differs from a rectangle. In an interview after the lesson, one student revealed how this terminology led her to believe that the two areas were the same.

A second purpose for integrating the *Geometer's Sketchpad* into this program is to illustrate how other micro-world programs can be implemented into the mathematics curriculum to facilitate the exploration of geometric concepts. By exposing preservice teachers to various applications of technology, they may be more inclined to use them in their own classrooms. For several semesters, we have administered an attitude instrument at the beginning and end of the elementary methods course and each semester have found significant improvements in preservice teachers' attitudes toward their ability to use technology in their own teaching. In the most recent use of the area-of-a-circle simulation, a preservice teacher discussed how she wanted to use The Geometer's Sketchpad program in her student teaching class and asked for more information and a user's manual.

Implementation

The area-of-a-circle video materials and software have been under development for three years. The process of revising and extending these materials has been driven by class observations, input from methods instructors, and written evaluations from preservice teachers. Originally, one HyperCard stack was created to integrate both content and pedagogical themes. When this version was used, approximately three 50- minute class periods were devoted to activities pertaining to the area-of-a-circle lesson including review of computer-based ancillary materials such as the teacher's lesson plan and an animation illustrating the content, the simulation using the stack, and follow-up class discussion. The methods course students completed the simulation activity with the stack working in small groups at video stations in the computer lab on campus. The simulation, however, was difficult to complete in one class period and yet, it was decided, did not warrant additional class time when competing goals and activities of the course were considered. A second consideration for modifying the original version of the stack was that students found the focus to be unclear. By separating the original stack into two stacks, one central theme could be considered at a time. In the most recent implementation of the area-of-a-circle lesson simulation, the teacher education students, situated at the video stations in the computer lab, discussed the content stack during the first part of the class period. The instructor then, in a presentation format, selected portions of the pedagogy stack to lead a class discussion focusing on critical pedagogical incidents that occurred in the lesson. An alternative implementation model considered for the future is to have students use one simulation in class and complete an assignment with the other stack outside the class.

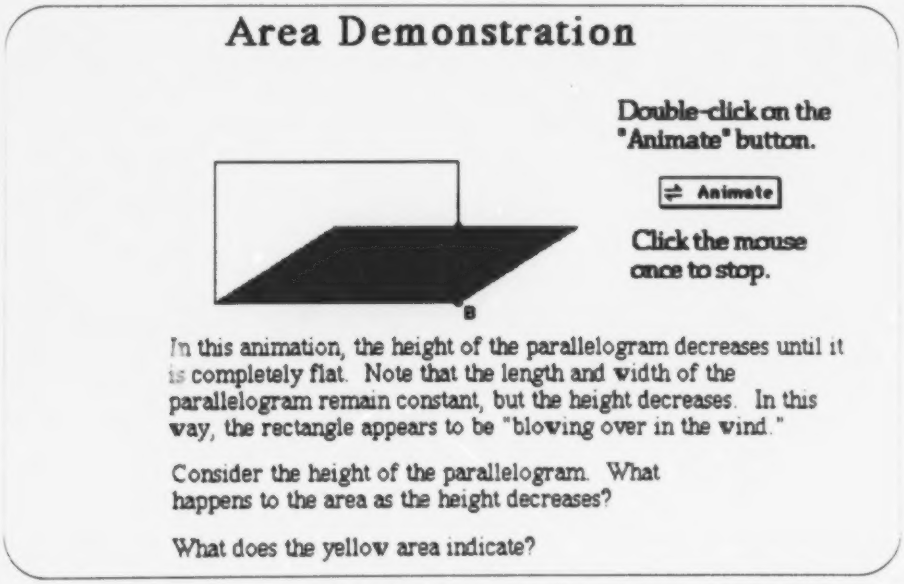
For class sessions involving interactive video, groups of three or four are situated at video stations containing a Macintosh LC II computer and monitor, and a videodisc player and monitor. On the basis of written comments, the group numbers have been limited to no more than four to a station to alleviate overcrowding. During early implementations the sound from six different videodisc stations all playing different segments was distracting. To alleviate this sound distraction, headphone connector boxes were created to enable each group member to hear only their own video sound.

Assessment

Various forms of assessment have been used to evaluate the effectiveness of the area-of-a-circle lesson simulation. Through anonymous written evaluations, preservice teachers have expressed positive reactions as well as some constructive suggestions that have influenced design revisions. The methods course students have also been asked to describe what insights and understanding they gained from participating in the activity. Nearly half mentioned the importance of teacher reflection, the use of manipulatives, and the active involvement of learners (Barron, 1993).

A second form of assessment of the area-of-a-circle lesson has included asking groups of two or three students to design a lesson plan for a related lesson. Methods used in the students' lesson plans were compared to those presented in the area-of-a-circle lesson. Students incorporated several teaching techniques from the video lesson into the lesson plans they produced. In particular, they emphasized clearly stated objectives, review of previous material, incorporation of estimation, use of calculators and manipulatives, and evidence of anticipation of pupil difficulties or misconceptions (Barron, 1993).

New forms of assessment are presently concentrating on how effective the simulation materials are in stimulating discourse among group of students. If researchers conceptualize learning as a socially constructed and negotiated process, assessment must be devised accordingly. For this reason, preservice teachers engaged in the simulation are being videotaped and audiotaped to gain a deeper understanding of their interactions. Analyses of the transcribed discourse enable researchers to engage in a reflective process of examining the content and patterns of the students' conversations. Additionally, this opportunity allows the developers of the simulation activity to reexamine the goal of the simulation as well as those of preservice teacher education in the methods courses. As Balacheff (1991) suggests, research must become an interactive process in which the researchers and informants engage in discussion interpretation. To this end, volunteer preservice teachers are also being interviewed to gain a broader view of their constructed understandings and reactions to the simulations.



Area Demonstration

Double-click on the "Animate" button.

Click the mouse once to stop.

In this animation, the height of the parallelogram decreases until it is completely flat. Note that the length and width of the parallelogram remain constant, but the height decreases. In this way, the rectangle appears to be "blowing over in the wind."

Consider the height of the parallelogram. What happens to the area as the height decreases?

What does the yellow area indicate?

Figure 2. Geometer's Sketchpad activity illustrating the difference between area of a parallelogram and rectangle having corresponding sides of equal length.

After several passes through the cycle of development, implementation, evaluation, and revision of the simulations, insights into the process of preservice teacher education have been gained. Overall, the use of technology has proven fruitful but labor-intensive. That is, the time devoted to preparing class handouts, setting up the computer lab, and developing appropriate activities has been demanding. The attempt to introduce simulated classroom situations has successfully elicited changes in preservice teachers' written responses, but the question of whether a change in epistemology has occurred cannot be measured without viewing these teachers in their first years on the job. Several benefits of the simulation have been determined: 1) the use of technology enables methods instructors to present problematic situations within a realistic context, 2) independent, reflective thinking appears to be encouraged through the small group format and the use of an integrated media environment that permits students to proceed through the simulation at their own pace and work independently, and 3) introducing technology within the preservice curriculum supports Brooks' (1990) assumption that if first year teachers are expected to be innovative users of technology, then they must be exposed to it at all levels of their preparatory education. The area-of-a-circle simulation and related micro-world programs are designed to help preservice teachers enhance their understanding of mathematical concepts and to enable them to reflect on pedagogical practices by considering multiple perspectives.

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Integrating Information Technology Into the Elementary Mathematics Curriculum

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The first phase of integrating information technology into the teacher training curriculum at Brockport began in the Fall semester of 1990 when the Elementary Mathematics Methods course was taught in the new computer laboratory facility. The hardware and software which make up most of the laboratory were received through a grant from the IBM Corporation. The equipment arrived on the Brockport campus during the Spring semester of 1990 and the laboratory set up in the late summer.

The heart of the Teacher Education Computer Laboratory is based on a Local Area Network (LAN) of fifteen (15) IBM PS/2 Model 25s running on a Base Band network with an IBM PS/2 Model 80 as the file server. All IBM educational software is available to teacher education students on the file server. There are also two (2) IBM Proprinter III dot matrix printers attached to the network. In the near future, the network will be tied to the outside world by means of a modem.

The focus of the grant was to implement computer and information technology into all aspects of the teacher training programs at Brockport. This would assure that new teachers entering the field will have the background and experience necessary to use the equipment they will find in the schools. It would also benefit the present school teachers in that they will be getting new colleagues who have been trained in the use of technology and can help them acquire essential skills.

Technology in the Classroom

The implementation of information technology into the teacher training curriculum focused initially on the Elementary Mathematics Methods course taught by the principal investigator. Since the grant provided considerable software in the elementary mathematics area, this was a good place to begin.

The Elementary Mathematics Methods course was replaced in the fall semester of 1992 with Applications of Teaching, of which one segment deals with mathematics methods. This new course is the second in a sequence that the elementary preservice students take. The course preceding it is called Dimensions of Teaching and can be thought of as a generic methods course.

Students in the Dimensions of Teaching course receive four three hour sessions in the computer lab to acquaint them with the computer and Microsoft Works to assist them in personal productivity. One session is devoted to word processing, one to the use of the spreadsheet as a grade book, one to the use of the data base for maintaining student records, and one to the integration of word processing and the data base to create form letters for students. In addition, this period of time is used to introduce the students to the use of the local area network as part of their everyday practice.

The mathematics methods component of the Application of Teaching course meets for a total of twelve (12) ninety minute sessions. Eleven of those sessions included the use of information technology as it related to the teaching of elementary mathematics. Each session is focused on a topic and the lecture presentation, manipulative activities, and computer activities center around that topic. The topic areas are shown in the table below along with the manipulative materials and software used for each class.

Each class session was subdivided into three parts. First a lecture/discussion of the topic and a follow up to any questions regarding the readings done. Next, each class had some kind of hands-on activity to introduce the students to the use of concrete materials and how to instruct children with those materials. Finally, for the last part of each class, the students were assigned specific software packages to use from the file server. The software used was the Mathematics Concepts - Level I, Level II, Level III, and Level IV, published by IBM. Specific parts of this software were selected to reinforce the lecture/discussion and manipulative parts of the class. For example, after a discussion of the use of Base 10 Blocks to teach addition and subtraction of whole numbers, and after actual hands-on exercises with those materials, the students would use one of the software packages which visually manipulated icons representing the same concrete materials.

Evaluation

During each semester two techniques were employed to measure the effectiveness of the implementation of computers into the Elementary Preservice program. First the Microcomputer Attitude Scale developed by Abdel-Gaid, Cecil R. Trueblood, and Robert L. Shrigley and published in the Journal of Research in Science Teaching, December, 1986, was given as both a pretest and a posttest to see if any shift in group attitudes towards computers could be detected after spending a semester using them in a class situation.

Second, a randomly selected group of students from the class were given exit interviews to determine their feelings toward the class and particularly the use of computers in that class.

Microcomputer Attitude Scale

The Microcomputer Attitude Scale is composed of twenty-three questions which focused on the student's attitudes in five general areas:

1. The importance of microcomputers in the schools
2. Student and teacher attitudes and anxieties toward microcomputers
3. The effect of computers on student achievement and thinking skills
4. Teacher/student involvement (extra work load, student contact, etc.)
5. The importance of programming skills

The students in this study appeared to be quite sophisticated in their views of the importance of computers in the public school curriculum. This resulted in high positive attitudes on the pretest and no significant change in scores on the posttest for those questions. The implication is that this group of students believes that microcomputers are very important in the public school classroom and that belief did not change during the semester.

Questions related to the role or importance of programming to both students and teachers has a similar response pattern. In fact, the semester of exposure to computers and educational software served to strengthen the student concept that programming skills are not important for either teacher of student in the public schools.

Questions related to teacher/student involvement indicated two major changes in attitude. The students in this study began the semester feeling that all teachers should be taught how to use microcomputers and ended the semester with an even stronger feeling that such training was necessary. On the other hand, these students began the semester feeling that too much attention and emphasis was being given to computer technology which detracted from the real problems in the schools. By the end of the semester that position had changed significantly and the students felt that such a detraction did not exist or that the emphasis on technology was warranted.

One of the two areas with the largest number of significant change in mean scores was where the questions dealt with student and teacher attitudes and anxiety. The attitude of the students shifted significantly from the belief that both teachers and students would have increased anxiety with the increased use of microcomputers. There was also a significant shift from the pretest belief that microcomputers would not improve student attitudes toward school subjects. In addition, the students changed their attitude that microcomputers would decrease the amount of teacher-pupil interaction in schools between the pretest and the posttest.

The last area in which the students in this study showed a significant attitude change over the semester is that of student achievement and thinking skills. The students began the semester feeling that microcomputers would not make better thinkers of their pupils and that standardized test scores and traditional skills would decrease. This attitude was reversed by the end of the semester after the students had the opportunity to work first hand with some of the available software.

Exit Interviews

Exit interviews were conducted with groups of randomly selected students upon completion of the classes. These groups completed a brief short-response questionnaire and participated in an open-ended discussion regarding use of the computer classroom. The instructor was not present at this session to encourage students to speak freely.

The written portion included a question regarding prior computer experience which would be expected to temper students' familiarity with and use of computers in the classroom. The results showed a fairly sophisticated sample. In approximately two-thirds of this sample, students reported using a computer at home, half reported using the computer at least monthly, and the remaining students used the computer weekly or more frequently.

When asked how the use of the computer added or detracted from the class, all respondents felt that the computer added to their learning experience. Specifically, students mentioned that using the computer showed another way to teach and reinforce mathematics concepts covered in class, and more importantly, was a great alternative to dittos.

Students were of a divided opinion when asked if

Table 1
The mathematics methods component of the Application of Teaching course

TOPIC AREA	MANIPULATIVES	SOFTWARE
Pre-Number Concepts Mathematics Learning	Attribute Blocks	Moptown Parade, Measurement, Time & Money
Numeration Systems & Other Number Bases	Multi-Base Blocks in base 10, base 5 & base 6	Math Concepts - Level P & Level I - Activities using Blocks to show quantities
Addition and Subtraction of Whole Numbers	Multi-Base Blocks in base 5 & base 6	Math Concepts - Level P & Level I - Block activities - Addition & Subtraction
Multiplication and Division of Whole Numbers	Multi-Base Blocks in base 5 & base 6	Math Concepts - Level I & Level II - Block activities - Multiplication & Division
Number Theory	Balance Beams Sieve of Eratosthenes	Math Concepts - Level II - Comparing Fractions
Rational Numbers	Fraction Circles & Fraction Bars	Math Concepts - Level III - Operations with Fractions
Computers in the Classroom	Videotape of Project Ulysses	Primary Editor Plus
Geometry	Geoboards	Math Concepts - Level III - Geometry Activities
Measurement	Trundle wheel, meter sticks, inclinometer, etc.	Measurement, Time & Money - Measure It
Organizing, Representing, & Interpreting Data	Unifix Cubes with activities related to data gathered from students (birthdays, etc.)	Measurement, Time & Money - Graph Maker Tool
Problem Solving, Diagnosis & Planning for Instruction	Möbius Strip, puzzles, games, problems, and lesson plan worksheets	Word Processing & Spread Sheet in Microsoft Works

computers in the class helped their understanding of the material. While most felt that it was useful to have some experience with the different software available, they pointed out that the concepts illustrated were things they should already have mastered. Students who already understood the concepts projected that classroom use of a computer could then degenerate to 'busy work' when the novelty wore off. Still, at least a quarter of those asked believed that the software (though elementary) did provide a review of their own basic math skills.

Those who got the most out of experience with the software reported using it to concentrate on the steps and process used to accomplish various learning tasks. They focused on ways these steps and processes could be imparted to new learners (both with and without computers). One mentioned that use of computers as another visual aid for presenting information was always helpful in understanding math.

When asked if they could envision themselves using computers in their own teaching classrooms, the groups all said yes. A few qualified their response, hoping for a tighter integration of computers and software use for mathematics education with computer use for other subject areas as well as classroom management tasks. Summing up their feelings was the comment that "Computers are the future; we all need to know how to use them."

An open-ended discussion on feedback on use of the lab followed. Highlights of comments are shown below:

- Using computers reinforced their own learning processes and they projected that it will do the same for their future students.
- They felt the computer work did include a component related to learning at a manipulative level because students had to push a button and it can provide tactile, auditory, and visual feedback.
- Computers can lose their advantage when the novelty of using the software wears off or becomes predictable.
- Students envisioned that noise could be bothersome; it was suggested that the audio effects of the software be muted in a classroom situation. Headsets (although awkward) were mentioned as an alternative.
- Computers should be used to reinforce concepts but were generally not concrete enough to introduce concepts.
- Computers cannot replace good teaching; but should be used to reinforce learning, as a motivator and as a reward.
- In evaluating software, it was suggested that instead of the student teachers doing it, actual elementary and secondary students should be brought in and their responses observed. How does it work with younger learners?
- They felt that computers and educational software should have been integrated into their curriculum earlier and integrated into their other methods courses. They reported that some students from previous semesters felt cheated in not having had computer experience.
- They did not want to take time away from the methods classes, but suggested perhaps working with computers in a separate lab on material closely related to what was being covered in the methods course.
- They did not feel that integrating computers into the curriculum was an added burden.
- In terms of their future, these students knew that computers are useful, not a fad, and there is no way to go backward to precomputer days.
- They were definitely used to seeing computers (generally Apples) in the participating schools they were student teaching at and were interested in receiving information for funding of computers in their schools.
- They indicated they would actively campaign for getting computers in classrooms that did not have them.
- The role and importance of using computers with special education students was also mentioned.

Future Directions

After working with the classroom LAN for a period of four semesters and evaluating the process, some changes have been planned for the future. First, we are moving to establish model classrooms in two or three other rooms using two to four computers hooked into the network. This will give the science, social studies, and language arts methods classes access to the network in their normal daily classroom which in turn should lead to the future teachers integration into their daily routines. Second, we are attempting to establish an electronic classroom where the medium of instruction would be computer based which would give the future teachers a model of how to use the technology in the instructional setting. Finally, students will be required to use the microcomputer lab more during hours outside class and assignments will be recorded on the network itself saving time and paperwork for the instructor.

Conclusions

The first four semesters of implementation of the new IBM classroom LAN have been very successful. In a period of a few short weeks student attitudes were changed significantly and in a positive direction. The mission of the project was to produce teachers who were not only comfortable with the technology, but were capable of implementing it in their own daily teaching. We believe we've come a long way in that direction in a short period of time.

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Developing a Computer Assisted Mathematics Tutorial for Preservice Teachers: Some Pedagogical Issues

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The purpose of the project described here is to develop a computer-assisted mathematics tutorial using HyperCard for "at-risk" preservice educators specializing in primary and early childhood. This paper will focus specifically on pedagogical aspects of the tutorial package design because in order to fully exploit the potential of a hypertutor system it is important to consider the learning principles underlying its use (Huston, 1990). Before discussing the learning principles underlying the design of the tutorial, however, let us consider briefly the background of the project and the reason for its importance.

Background

This project arose from long-time concern about the inadequacy of mathematical skills of many students entering primary and early childhood education courses at the Launceston campus of the University of Tasmania. A range of tests has indicated that many of these students perform below acceptable levels. This lack of sufficient mathematical skills continues to be a problem despite the importance of primary and early childhood teachers being at least functionally competent at mathematics (Department of Employment, Education and Training, Australia, 1989). This problem is not confined only to a local context. It exists on a much wider basis and is further compounded by the fact that many preservice primary and early childhood students have poor attitudes towards mathematics (Aiken, 1976; Clark-Meeks, Quisenberry and Mouw, 1982). A potential consequence of not addressing the problem is that preservice teachers with low skills and high mathematics anxiety become "teachers who lack confidence in mathematics and, as a result, are reluctant and ineffective mathematics teachers who find it difficult to adapt new curricula into their classrooms .... another generation of teachers who are deficient in mathematics is created, thus perpetuating the cycle" (Bitter, 1987, pp. 106-7).

In Australia, the national *Discipline Review of Teacher Education in Mathematics and Science Education* (Department of Employment, Education and Training, Australia, 1989) recommended that institutions take steps to guarantee that graduating students have sound mathematical knowledge, are competent in lower secondary mathematics, and have developed a positive attitude towards the subject" (Volume 1, p. 68). With recent developments in computer technology, and particularly in the area of computer assisted learning (CAL), it is opportune to explore the use of a teaching medium which can be administered to individual or small groups of students, will allow for the monitoring of their progress, and will teach the basic skills and knowledge they need to participate effectively in the regular mathematics education program.

While studies have found CAL remediation to be at least as effective in producing correct answers on post-treatment tests as other types of remediation (Bitter and Cameron ,1988; Tirosh, Tirosh, Graeber and Wilson, 1991; Plomp, Pilon and Reinen, 1991), it also offers some advantages which other forms of remediation do not. These advantages include economic considerations (Plomp et al. 1991; Bitter and Cameron, 1988), the motivational effect of allowing students to work individually and be self-paced (Plomp et al. 1991), the personalised nature of the interaction between computer and user, the endless patience of the computer, and its ability to communicate individually and on a non-threatening basis (Bitter and Cameron, 1988).

One of the main advantages of computer assisted instruction is its potential to provide individual programs to suit the different needs and learning styles of students, in a way which would not be practical in a group lecture or tutorial (Ross and Anand, 1987). Other advantages are the availability of immediate feedback, individualised programs, student control of pace, sequencing and content (Bourne, 1990). Furthermore, regardless of the length of time or number of attempts the student needs to complete the program, all students will end up having achieved consistent outcomes, an endpoint which is not as easily achievable with a one-off lecture or tutorial (Bourne, 1990).

Design Features of the Tutorial Package

The pedagogical framework for the tutorial is based on the Hypertutor Model proposed by Johnson and Grover (1993). This model incorporates five parameters: presentation, learning resources, learner control, practice, and feedback. Each of these will now be discussed in relation to the tutorial package.

Presentation

Presentation is mainly concerned with design issues such as general screen formats, visual design issues, special visual effects and choice of fonts which are outside the scope of this paper but have been discussed elsewhere (James and Taplin, 1993). However, a pedagogical issue discussed in this category by Johnson and Grover (1993) is the content of the tutorial and the logical sequencing of the content.

Content is clearly critical to the effectiveness of the tutorial, so the processes involved in deciding this content will be discussed here in some detail. The aim of the tutorial is to provide opportunity for the development of adequate mathematical knowledge according to students' specific needs. One important question which needs to be addressed in the design of this remediation package is that of what constitutes adequate mathematical knowledge (Simon, 1993). Simon (1993) and Eisenhart, Borko, Underhill, Brown, Jones and Agard (1993) discuss two types of knowledge which are important for teachers to have in order to be effective in teaching a mathematical concept. One of these is procedural knowledge, which refers to knowledge of the rules, procedures and symbols needed to complete the task. The other is conceptual knowledge which refers to the ability to understand the concept and connect or apply the pieces of knowledge. They suggest that teachers tend to place a great deal of emphasis on procedural knowledge and little on conceptual knowledge. Thus it is important for student teachers to be suitably equipped to provide a more even balance between the two. In order to facilitate this balance between conceptual and procedural knowledge it will be necessary to restrict the breadth of content which *could* be covered by this package and to focus on the most serious problems which the student teachers demonstrate. It must be noted, too, that this empirical aspect of mathematics is only one of the three categories of mathematical content suggested by the National Council for Teachers of Mathematics (Sullivan, Clarke, Spandel and Wallbridge ,1992). Students should also be able to make generalisations, describe relationships and demonstrate higher order reasoning skills. As Sullivan et al. point out, it is potentially more useful for a child to develop skills for "exploration of a mathematical task, which highlights connections to existing knowledge" (p. 2) than for the teacher to simply tell the child how to do the procedure. The quantity of mathematical knowledge which exists and its constantly changing nature make it impossible to learn it all by rote (Sullivan et al., 1992). For the same reason, it would be inappropriate for the CAL package to focus solely on transmitting mathematical knowledge. Furthermore, arguments have been presented that ability to relate to the context in which knowledge is embedded is as important a component of learning mathematics as is the knowledge itself (Cobb, 1986; Sullivan et al., 1992; Simon, 1993; Reeves, 1993). If teachers are to be able to guide children to adapt knowledge to a variety of contexts or construct their own systems of knowledge, it is first necessary for the teachers to be able to do it themselves.

Over a period of four years, two testing instruments were used to collect information about the content areas in which student teachers were performing unsatisfactorily. These were the ACER Mathematics Profile Series Review Test (Australian Council for Educational Research, 1983) and a test of basic mathematics concepts given to students in the first year of their teacher education course. These tests covered topics described by Cockcroft (1982) as being essential minimum requirements for students completing secondary school. Questions on which students performed poorly were primarily those requiring the transfer of problem solving skills to unfamiliar situations. The specific content areas in which the majority performed poorly were: the metric system, algebraic manipulations, linking decimals, fractions and percentages, equivalent fractions, division of fractions, multiplication and division of decimals, and formulae used in measurement, for example volume, circumference and area. After they had been shown the answers to the test questions, the students were asked to reflect on the questions they had wrong and suggest why they might have made mistakes. The most common reasons, other than careless errors, were forgetting the rules, never having been taught the rules, or not knowing how to apply the rules to unfamiliar situations.

The other consideration in the presentation of the package is the modelling of appropriate strategies which the student teachers can eventually use in their own classes (Tirosh et al., 1991). The main strategies identified by previous writers as being important for preservice teachers to develop are: the use of diagram (Tirosh et al., 1991); the use of concrete aids to demonstrate a concept (Watson, 1986); and the use of either visualisation and drawing or a verbal/logical approach which allows for aspects of the

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representation to be manipulated in one's mind (Battista, Wheatley, Grayson and Talsma, 1989).

A group of 25 student teachers, mathematics students and mathematicians was asked to solve a selection of the problems to be included in the package and to fully describe the processes used. These processes were categorised into:

(i) visualising a 3-dimensional model of the problem
(ii) drawing a 2-dimensional representation
(iii) using equations
(iv) rewriting the conditions of the problem in longhand, i.e. in their own words.

For each problem, the package will offer a series of appropriate strategies within the four sub-headings indicated above. Selection of one of these subheadings will encourage the students to monitor their selection of strategies. Sequences of cues will be presented for each strategy, and students will be able to request successive cues if needed. When a correct solution is reached, immediate feedback will be given so that the student can move on to the next problem.

Based on the analyses of the tests given to the student teachers, and the recommendations of previous writers listed above, the following were identified as being important criteria for each item to be included in the tutorial:

(i) revision (or in some cases establishment) of knowledge fundamental to teaching mathematics in the primary classroom
(ii) development of skills to transfer this knowledge to unfamiliar situations using a variety of strategies
(iii) awareness of common misconceptions in an attempt to eliminate/monitor/control these
(iv) modelling of instructional strategies which can be used in the classroom
(v) provision to make generalisations, invent rules and formulae etc. in relation to the knowledge, thus encouraging the student to think in a more eclectic manner.

The sequencing of content is another important issue described by Johnson and Grover (1993). In this package each problem solving strand follows the same sequence of strategies:

- Write down the information which is given.
- What further information do you need to solve the problem?
- List the steps involved in solving the problem.
- How can you relate the answer back to the problem?
- Is it possible to make a generalisation about the problem?

Although each strand gives the response to these questions in a different format, namely diagram, equation or verbalisation, they are identical in sequencing logic. It must be noted, however, that the hypermedia environment allows for traversing across the tutorial in a multi-dimensional fashion.

Learning Resources

Johnson and Groovier (1993) suggest that the role of learning resources is becoming increasingly important in the design of interactive instruction with "the increasing recognition of the value of learner control, self-regulation, and continuing motivation factors" (p. 13). It is important for the active learner to have access to learning resources, including hypertext glossaries, charts, help etc., in order to "facilitate deeper, more elaborative, cognitive processing in pursuit of instructional objectives" (p. 13). The nature of using a hypermedia system allows the learner to link concepts and learning resources without having to leave the working environment , and to be able to access the learning resources in a non-linear way which reflects better the way people think (Marsh and Kumara, 1992). A feature of the package will be an online calculator and a background knowledge base which the user can access at any time without leaving the screen currently being displayed. The knowledge base will contain definitions, formulae and other information required to solve the problem. The inclusion of this feature, plus online navigation help, will provide "enough structure and help functions to ensure that the student eventually ends up obtaining knowledge, rather than just bewilderingly discreet bits of information" (Bourn, 1990, p.169)

Learner Control

Johnson and Grover (1993) refer to a wide range of learning theories which characterise the active learner and which should therefore be taken into account in designing interactive instruction. These include provision to allow the learner to: continually process and re-organise information, learn through observation and example, and set goals, organise, self pace, self-monitor and self-evaluate.

The learner does not have to depend on a pre-determined sequence of instructions, but is able to select the most appropriate sequence (Underwood, 1989).

The tutorial program will be menu-driven. A pretest will identify the items which each student will need to complete. The student will then be able to select a particular problem, select the preferred solution strategy, access background knowledge, re-read the problem, change to a different set of hints or access a calculator. The learner will have total control of choosing the most appropriate path to follow.

Practice

Johnson and Grover (1993) believe that hypertutor systems provide the opportunity to access a wide range of items which can facilitate sufficient practice to enable mastery of learning. Practice can also be enhanced because the system can organise "complex, hierarchical problem solving processes into a series of simple steps" (p. 11). Another important feature of a tutoring system is its facility to allow the user to "back up and try a different tack" (Underwood, 1989, p. 74) if the student is experiencing difficulty with a particular approach.

Johnson and Grover refer specifically to mathematics learning when they point out that frustration and wasted time can be caused by the learner searching for errors. They suggest that hypertutor systems can address this problem by providing immediate feedback at every step of the problem solving process. This is the case in this package. The hint screens ask a series of questions described earlier in this paper. After each of these question screens, the students are able to attempt to work out their own responses before going on to the following screen which provides an immediate answer to the question and shows how this answer was worked out. The students can re-work this question/answer process as many times as is necessary before moving on to the next hint.

Feedback

Another of the features of hypertutor systems described by Johnson and Grover (1993) is the provision for "immediate, frequent, appropriate, and varied feedback" (p. 11) and toleration of rounding errors. Johnson and Grover cite a number of functionalists and operant behaviorists who have focused on the importance of learning appropriate feedback. In this package the student can "try the answer" at any time. The facility exists to accept rounding errors where it is appropriate to do so. Feedback is given immediately and if the answer is incorrect the student is advised to work through the tutorial, either continuing from the same place or trying a different strategy.

Conclusion

This paper has explained some of the pedagogical issues which have made hypermedia an appropriate vehicle for a mathematics remediation program. One of the reasons for using hypermedia is because it is conducive to accessing supplementary materials such as appendices, examples and background information quickly and easily (Ambrose, 1991). This facility was essential for this program to be able to present a problem context but to also make background knowledge, calculator facilities, and hints readily accessible to the user at the moment when they were required. By allowing the students to select their own routes through the program and consequently to make decisions about these routes, Hypermedia allows the creation of a program which is based on the development of conceptual thinking rather than just the mechanical learning of skills (Bourne, 1990). A further reason for using a hypertutor system is its facility to record the paths the user chooses to follow through the material or the length of time spent on each card (Marsh and Kumar, 1992). Not only will this facility have the potential to enable the students to develop a greater understanding of their learning (Ambrose, 1991), it will also facilitate further research into the particular problems and also the preferred learning styles of the users.

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Mathematica-Based Mathematics for Elementary Teachers: An Experimental Course

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All recent mathematics reform documents (e.g., Mathematical Association of America, 1991; Mathematical Sciences Education Board of the National Research Council, 1991; National Council of Teachers of Mathematics, 1989,1991) have called for improved and increased use of technology in mathematics instruction, both in school mathematics and in teacher preparation programs. The University of Illinois at Urbana-Champaign has redesigned one of its mathematics courses for elementary teachers to teach concepts of the calculus using *Mathematica* (*Mathematica* is a registered trademark of Wolfram Research, Inc.) This course, "Experimental Mathematics," is experimental in two senses: it encourages students to perform mathematical experiments using *Mathematica*, and the course itself is new and, hence, experimental.

Course Goals and Content

The primary course goal is to use computers to deepen students' understanding of mathematics so that they leave the course understanding that doing mathematics means finding patterns, investigating change, creating and testing hypotheses, and solving real world problems. In short, the main course goal is to use computing technology to promote active learning. A concomitant course goal is to impress upon students the beauty and power of mathematics.

In order to achieve these goals, it was necessary to select both appropriate mathematical content and an appropriate computing platform. Topics from calculus were chosen for three compelling reasons. Calculus is a natural progression from the mathematics these students had in high school. It would have been their next course if they had continued in mathematics. Furthermore, the National Council of Teachers of Mathematics (1989) calls for all college-intending 12th-grade students to learn the concepts of the calculus. Until those recommendations are adopted by Illinois high schools, teaching calculus in this course is the easiest way to expose these students to this content. Second, the calculus has great utility in the natural and social sciences. This enables us to illustrate its power in solving real-world problems in a variety of domains. Finally, the calculus has great beauty, and it generally is regarded as the greatest invention of human reasoning (e.g., Bell, 1951; Kline, 1985).

The computer algebra system *Mathematica* was chosen as the course software because it allows text, plots, and commands can be integrated into one file called a "*Mathematica* notebook." This feature allows the development of "electronic textbooks," which provide students with explanations, examples, exercises, and experiments. One could describe a notebook as an animated textbook: Students read textual explanation, activate Math*ematica* input commands that perform the calculations and plotting, study the output, and then write and execute similar sequences themselves. Furthermore, because commands, plots, and text can be integrated in *Mathematica notebooks*, students can be assigned projects that ask them to do and explain mathematics, an important skill for prospective teachers.

Although topics from the calculus and the *Mathematica* software were chosen for mathematical and pedagogical reasons, there were significant practical advantages to be gained from selecting them. Most of these advantages accrued from the University's long involvement with the National Science Foundation-funded Calculus and *Mathematica* Project, which developed a *Mathematica*-based calculus sequence for science, mathematics, and engineering majors. Professors Porta and Uhl, who along with Professor Davis at Ohio State, wrote Calculus and *Mathematica* (Davis, Porta, & Uhl, 1993), supported this teacher education effort, and graciously encouraged the use of their materials as models. All of these advantages outweighed the two main drawbacks to using *Mathematica:* its arcane syntax and its complexity, which is a direct consequence of its power.

This course, however, is not Calculus and *Mathematica*. Its lessons were written for a different audience with different goals. The intention is not to teach calculus per se, but to use the calculus to open up a realm of exciting mathematical ideas. Course topics include numeracy, graphing polynomials, linear growth, instantaneous growth, and integration.

Sample Mathematics

In order to give a flavor of course content, seven examples are presented below. The first three are homework (Give It A Try) problems to be done on the computer, the fourth is a "Literacy problem" to be done away from the computer, and the last three also are Give It A Try problems. The first example (Unit 1, G.4) was chosen from an early lesson designed to introduce students to *Mathematica* and promote looking for patterns and making conjectures. The second example (Unit 3, G.3) is similar, only this time students are to use *Mathematica*'s plotting capability. The third example (Unit 5, G.3), is a homework problem on a familiar application of derivative. The fourth (Unit 5, L.12) is a Literacy Problem that students are to solve away from the computer. (Literacy problems give students a chance to test their conceptual understanding.) The last three examples (Unit 6, G.3, e, g,h) are typical relative extrema problems from the calculus. Those problems that originally were developed for Calculus & *Mathematica* are denoted by C&M; those developed specifically for Experimental Mathematics are denoted by EM.

Unit 1. Numbers and Algebra. Powers of 1/2. (G.4) C&M

1. Combine the following equations into single fractions: a) $1/2 + 1/2^2$
   b) $1/2 + 1/2^2 + 1/2^3$
   c) $1/2 + 1/2^2 + 1/2^3 + 1/2^4$
   d) $1/2 + 1/2^2 + 1/2^3 + 1/2^4 + 1/2^5$
   e) $1/2 + 1/2^2 + 1/2^3 + 1/2^4 + 1/2^5 + 1/2^6$
2. In each of the above equations, how is the determinator of the your answer related to the denominator of the last term in the equation?
3. Using what you have learned in problems 1 and 2, combine $1/2 + 1/2^2 + 1/2^3 + \quad + 1/2^n$ into a single fraction, assuming that n is a positive integer? (Be sure to test it with actual data!)

Unit 3. More Functions. Comparing Plots. (G.3) C&M

1. Looking at a plot of $f(x)$ and $f(x+1)$ for $f(x)=x^2$ on the same axis where $-2\leq x\leq 2$, describe any similarities between the plots.
2. Plot $f(x-1)$ and $f(x)$ for $f(x)=x^2$ on the same axis where $-2\leq x\leq 2$. Describe the two graphs. (How are they similar? How are they different?)
3. Plot $f(x+l)$ and $f(x)$ for $f(x)=|x|$ on the same axis where $-4\leq x\leq 4$. Describe the two graphs. (How are they similar? How are they different?)
4. Plot $f(x-2)$ and $f(x)$ for $f(x)=|x|$ on the same axis where $-4\leq x\leq 4$. Describe the two graphs. (How are they similar? How are they different?)
5. Given the plot of $f(x)=y$, how would you graph the equations $f(x+l)=y$ and $f(x-l)=y$.

Unit 5. Instantaneous Growth. Wonder Woman. (G.3) EM

1. Ever since the "death" of Superman, Wonder Woman has noticed a distinct increase in the demand for super heroes. In the problems below, use the function that describes the height of an object above the ground, $s(t)= -0.49t^2 + v_0t + s_0$. Remember that v_0 is the initial velocity of the object and s_0 is its initial height. One day, Wonder Woman rescues King Kong. King Kong was on top of the Empire State Building, 360 meters above ground, when he fell.
   A. Plot King Kong' s fall.
   B. How long will it take King Kong before he hits the ground?
   C. What will his velocity be at impact?
   D. How fast will King Kong be going at impact in miles per hour?
   E. The Superman Fan Club is holding its "Going Out of Business Sale" on the 50th floor, 152 meters above ground. What is King Kong's velocity in miles per hour as he passes the 50th floor?
   F. Five (5) seconds afore King Kong falls, Wonder Woman arrives at the 86th floor observation deck, 262 meters above ground. In order to save King Kong, Wonder Woman dives off the observation deck.
      a. At what initial velocity must she leave the observation deck to catch King Kong 3 meters above the ground?
      b. What must her initial velocity be if she is to catch him as he passes the Superman Fan Club?
2. Sketch the graph of a function $f(x)$ whose instantaneous growth rate is positive for all x, that is $f'(x)>0$ for all x.
3. If $f'(x)>0$ for $0\leq x\leq 1$, then which is larger: $f(0)$ or $f(1)$?

Unit 6. Relative Extrema. EM

1. Michele lives on an island, but needs to go to town. The island is located 8 miles off the shore, directly opposite

Point A. The nearest town is located along the shore, 2 miles east of Point A, at Point B. If Michelle can row a boat at an average rate of 2 miles per hour and can walk at an average of 4 miles per hour, where should she land the boat along the shore so that she gets to the store the quickest?

2. The Pick & Eat grocery store wants to build a new grocery store. The new store will have a glass front and the other three walls will be made from brick. The total floor area required is 9,000 square feet. If a glass front costs $150 per linear foot and a brick wall costs $100 per linear foot, find the dimensions of the store so that the construction costs are minimized.
3. Using problem #2 above, include the cost of the roof and floor. If a concrete slab costs $25 per square foot and a truss roof costs $35 per square foot, find the dimensions of the store so that the construction costs are minimized.

Evaluation

This course is currently being taught, so not all of its evaluation has been completed. Students have completed surveys on their mathematical preparation and their attitudes coming into this course. At the end of the course, they will complete post-course attitude surveys to determine whether any changes occurred.

Students were asked to evaluate the curriculum after completing Units 1, 4, 6, and 7. A research assistant attended all the lectures and observed many of the labs. Sample homework papers and student projects have been collected and analyzed. Students have been interviewed throughout the semester, and some will be interviewed later in order to construct a more complete picture of the effects of the course.

Results

This project experienced many of the same problems familiar to anyone who has implemented computers into mathematics instruction: too few machines, network failures, hardware breakdowns, student anxiety about mathematics, and student anxiety about using computers. What is more interesting, however, is what this project has revealed about these students and the potential for computers to introduce concepts of the calculus to those who are not science, engineering, or mathematics majors. Furthermore, it gives good data on the mathematical preparation these students should have, as well as data on how the content and delivery of the Experimental Mathematics course should be improved.

Student Attitudes and Preparation

A pretest measuring their attitudes towards mathematics was administered at the second class meeting. The class consists of 91 students: 19 seniors, 71 juniors, and 1 sophomore. As a group, they are not fond of mathematics, and many feel anxious when doing mathematics: Only 25 students *disagreed* with the statement, "It scares me to death to have to take mathematics" and only 25 students agreed with the statement, "I enjoy taking mathematics classes." Additionally, the data report that 41 students do not feel calm when doing mathematics, 32 would not take any more mathematics if they had a choice, and 31 do not like helping others with mathematics (a curious result for prospective teachers).

These students are products of traditional mathematics instruction and about half have had no experience with computers of any kind. Unlike the case with Calculus and *Mathematica*, these students are not self-selected nor are they taking the calculus based on their results from a mathematics placement examination. This study reveals a loophole in College admissions procedures, although the College requires completion of Algebra II for admission, transfer students can be admitted with three years of any high school mathematics. Furthermore, few transfer students made up this deficiency in their junior college. (The course enrolled 30 transfer students, one-third of the entire class.)

This is a problem because the course is based on the assumption that students have completed Algebra II. Moreover, many of the students who have had Algebra II, completed it three or fours years ago and they have taken no subsequent mathematics. (This finding already has caused changes in College advising and admissions procedures.) Consequently, this class contains a wider range of student abilities and preparation than expected or preferred.

Course Successes

The most important success achieved in the course is that well over half the class is doing A or B work in learning the concepts of the calculus as measured by instructor-written examinations, homework assignments, and projects. Typical examination questions ask students to sketch plots, match plots of functions to plots of their derivatives, relate derivative to slope and change, relate the change in the function to the value of the derivative, and describe how they would solve relative extrema problems in *Mathematica*. Nearly all students are learning how to interpret graphs correctly and make sense of them. Additionally, for a number of students, the course began to "come together" while doing relative extrema problems in Unit 6 (Applications of Derivatives). Once the course came together, it became exciting for these students.

Discussions with students revealed additional successes. After a quiz, the research assistant explained to one of the students how to sketch the derivative from a plot of the function. At first she was confused, but once she began to understand it, she became excited. She thought it was "so neat." Not just that she could do it, but she thought the problem was neat.

Another student came into a teaching assistant's office and began to discuss her past experience in mathematics. She said that growing up, it was okay with her parents if she came home with a C in mathematics, although it was unacceptable to bring home a C in English and it was unacceptable for her brothers to bring home C's in mathematics. She said that her mother had told her that she was not very good at math, so it was okay that she did not do well in it. She said to the teaching assistant, "I think that we (females) can do better. Is that what this class is about?"

Another student said,

"I really like lectures now and I feel like you are teaching us something instead of us using trial and error on the computer. It seems as the semester moves on I am beginning to understand math again. My only concern is how is it going to relate to teaching children math. For example, unless I have a highly intelligent child in my class, I don't think I'll be teaching them derivatives."

Student Difficulties

There was considerable discomfort at the beginning of the semester as students learned to use the computers and *Mathematica*. About one-third of the class had some experience with Macintosh and only one had seen *Mathematica*. Because the students had virtually no programming experience, they found *Mathematica's* syntax of curly brackets, commas, double equal signs, and the occasional upper case letter confusing and frustrating. Even as the semester continued and the students' competency increased, the use of more sophisticated commands confused the students and distracted them from the mathematics at hand.

The evaluation data also demonstrate that it is helpful to offer accompanying lectures on the course material. Because students eventually stopped attending class lectures in Calculus & *Mathematica* courses, it was anticipated that students in this course likewise would not want lectures. This was not the case. Especially for the less able students, a lecture provides them with the structure necessary for understanding the computer lessons. Although having lectures runs counter to the spirit of the Calculus & *Mathematica* Project, these students are not self-selected and placed as are Calculus & *Mathematica* students, so they include a number of weaker students.

Many students found the instructional style of this course difficult, presumably as a result of their traditional mathematics instruction. In particular, they do not view mathematics as a field for experimentation, they have difficulty seeing intended patterns, and they solve problems without reflecting upon them. In short, their perception of mathematics is performing calculations quickly, accurately, and for the most part, without thinking.

For instance, there were several occasions throughout the course where executing a few simple *Mathematica* commands would have clarified important concepts, yet students did not use trial and error as a heuristic. They want to be given a model problem and then be told how to solve it.

It also is extremely difficult for these students to see relevant patterns. For example, students can plot the lines $f(x) = 8 - 1/2\ x$ and $g\ (x) = 8 + 1/2\ x$, see that $f(x)$ goes down and $g(x)$ goes up, yet still fail to see the link between the sign of the coefficient of x and the slope of the line. They can find the roots of a polynomial equation, but fail to see any connection between the number of roots and the degree of the polynomial. Other students found it difficult to make the connection that when $f(a) = 0$, then its plot intersects the x-axis at $x = a$.

Similarly, many of these students failed to relate their solution to the original problem. This became especially clear in Unit 6 while solving application problems. In Problem G.3.e above, students found that the minimum time occurred at an endpoint of the interval [0,2], but failed to realize that meant that the quickest way to the store is to row directly to it. Similarly in Problem G.3.h, students found the same solution they did for G.3.g, yet many failed to realize that this is because the roof and floor are *fixed* costs. Some students did, however, relate their solutions to the original problem.

Discussion

In addition to the results discussed above, this project raises questions about *which* precalculus mathematics should be taught. For example, the major difficulty students had in solving relative extrema problems was setting up the necessary equations. This suggests that more time should be spent teaching students how to set up equations. After all, *Mathematica* can plot and solve equations, but it can not set them up.

Implementing this project also raised questions about *which* concepts of the calculus should be taught. Exponential growth is one topic that was omitted that should have been included — it would have provided a helpful contrast to linear growth and it is common in the real world. Factoring polynomials and finding roots is another topic that should have been stressed more than it was — it would have helped clear up the idea of zeros of a function. The sheer power of *Mathematica* raises additional questions about which topics to include. For example, the second derivative test is extremely useful in a traditional calculus course because it helps students plot functions. Because *Mathematica* can plot any polynomial quickly, easily, and accurately, what role, if any, should the second derivative test have? Similarly, how much emphasis should the Fundamental Theorem of the Calculus have? It was taught to illustrate the power and beauty of the calculus, but how much detail is needed? Most of these students are not going further in mathematics, so a detailed explanation is not necessary, yet they should know enough to understand it.

Summary

Improving the mathematics preparation of elementary teachers is a critical component of improving school mathematics. Teaching these students the concepts of the calculus not only increases their understanding of important mathematics, but it also shows them what their students will see in higher mathematics. Furthermore, the calculus has great beauty and power. Coupling the calculus with computer algebra systems allows student to learn these concepts directly, without getting bogged down in arithmetic, algebra, or plotting. Slowly, these elementary majors are becoming active learners of mathematics by testing and checking hypotheses, looking for patterns, and exploring mathematical concepts. Despite the difficulties experienced so far, this course has great potential for deepening elementary teachers' understanding of mathematics, enhancing their appreciation of technology, and ultimately improving their teaching of mathematics.

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Essential Technology in Algebra Teaching Methods

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The National Council of Teachers of Mathematics (NCTM) has concentrated in the past few years on attempting to bring about dramatic changes in the methods used to teach mathematics courses in secondary schools. Changes in our society have necessitated changes in the mathematics curriculum. Advanced knowledge about the cognitive processes of students has allowed us to develop new strategies for teaching mathematics that have been shown to be much more effective than the old traditional methods.

The constructivist view of cognition, which is based on Piaget's theory of assimilation and accommodation, is the basis for constructivist teaching methods. This means that students must *experience* the concepts in order to internalize them and achieve understanding (Davis, Maher & Noddings, 1990). The constructivist learner is actively involved in the learning process and is able to interact significantly with the concept using some appropriate representation. When the internal representation approximates the external representation and appropriate connections are made to other related material, then understanding has occurred (Hiebert & Carpenter, 1992).

In the constructivist classroom, students actively participate in experiences that assist them in constructing their own concepts of these representations and the transitions between them. The emphasis in algebra classes must be on understanding and communicating these translations. If algebra instruction is modified to reflect the recommendations of the NCTM Standards, mathematics classrooms will become laboratories. Students will be actively involved in interesting and relevant tasks that aid in their internalization and formation of concepts. These changes in instructional methods will facilitate students' understanding as demonstrated by their ability to translate among multiple representations of a single conceptual context.

Discourse has been identified as a learning activity that facilitates algebra learning. Students are better able to "make sense" of a concept as they discuss the mathematics with peers and/or teachers (Corwin & Storeygard, 1992; Lodholz, 1990). The activity of having to form one's understanding into words forces metacognitive activity and, thus, improves thinking. Research studies have reported an increase in mathematical learning as a result of requiring students to share their thinking (Russell & Corwin, 1991). The recommended model is that students experience the mathematics and then seek understanding by discussion, including conjecturing, arguing, and justifying (Peterson & Knapp, 1993).

In traditional algebra courses, students learn to manipulate symbols by simplifying algebraic expressions and solving equations. This type of exercise has little or no connection to real world applications. Recent research and curriculum reform in mathematics education encourage us to make algebra more accessible to all students by making it more application-based (Glatzer & Lappan, 1990). This means that students should be able to translate freely among multiple representations: words, table, equation, graph. For example, if a student is given an equation such as $3x = 18$, he or she should be able to describe a problem situation for

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which the equation would be used. Similarly, given a graph, the student should be able to write "the story of the graph", translating it into words. In traditional courses, we ask students to translate *from* words, but the new emphasis is to have students demonstrate understanding by translating *to* words from other representations. Wagner and Kieran (1989) identify problem representation in an algebraic system as a key feature in algebra learning.

Facilitating Algebra Success Training (FAST)

Algebra has long been the cornerstone of high school mathematics. With the recent North Carolina mandate that one credit of algebra be a requirement for high school graduation, there was considerable interest among middle and high school mathematics teachers in improving the quality of algebra instruction. In assessing the algebra teaching in middle schools and high schools in one region, there appeared to be widespread use of traditional instructional methods. A number of algebra and pre-algebra teachers were informally interviewed. For the most part, the teachers were teaching the way they had been taught. These teachers were trained five to ten years ago using traditional teaching methods. A large majority of these teachers reported that they taught by "lecture, examples, practice" and "symbol manipulation." They recognized that these methods had limited success with many students. The teachers were concerned about the new "algebra for all" requirement. They felt that all students could not succeed in current algebra courses, and they were willing to learn new and better methods for teaching algebra in order to facilitate student success.

In 1989, the NCTM published *Curriculum and Evaluation Standards for School Mathematics,* and two years later published the *Professional Standards for Teaching Mathematics* (NCTM, 1991). These documents were the result of a careful examination and synthesis of the research evidence of what constitutes effective mathematics teaching. After careful examination of the NCTM NCTM Standards, key instructional components were identified: cooperative groups, problem solving, technology, and connections. These strategies, materials, and methods were strongly recommended for all school mathematics by the NCTM and were determined to be particularly appropriate for the teaching of pre-algebra and algebra in the middle and high school.

The NCTM Standards recommends that students be given opportunities to work in cooperative groups, and that activities be more student-centered and less teacher-centered. This is a radical change for many traditional teachers who feel that their primary responsibility is to lecture to students. Research has shown that students working in groups are more actively involved in the learning process and this participation results in higher achievement.

Problem solving is one of the major goals of mathematics education, and education in general. We cannot possibly teach our students a method for every problem they may encounter, so we must teach them skills for approaching unfamiliar problems. The NCTM Standards are very clear on this point; the "old days" of teaching a topic by demonstrating a particular algorithm and then having the students repeat the algorithm on twenty homework problems is not productive. Teachers must integrate problem solving activities to assist students in developing higher-order processes. Students must be challenged by problems that are within their reach, but at the same time are novel enough to require reflection and analysis. In short, students must be required to *think*.

The use of a technology for representation of algebraic relationships is an integral part of algebra instruction. The NCTM Standards recommends that all high school algebra students be taught to use a graphing tool. Numerous standardized measures of mathematics achievement, such as the North Carolina State End-of-Course Tests, the North Carolina State Mathematics Contest and the SAT, are incorporating graphing calculators. Graphing calculators and computers are essential tools in the algebra classroom. It is imperative that teachers learn to use this technology in their classes.

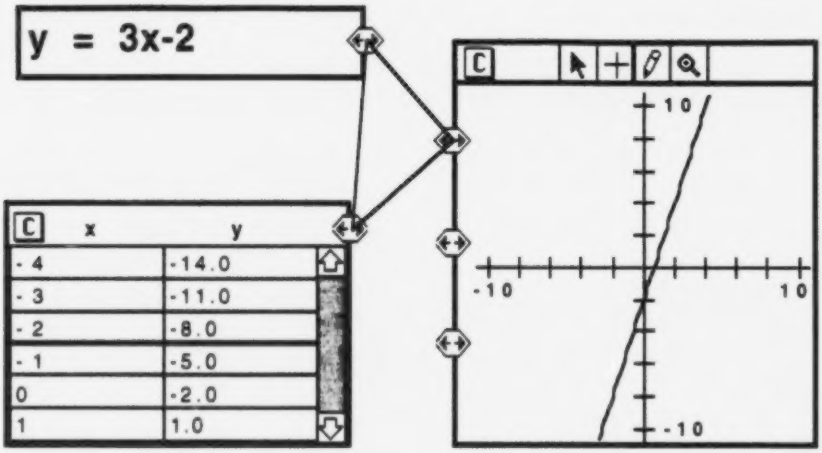
The final strategy is connections. The NCTM Standards states that students should be able to "apply algebraic methods to solve a variety of real-world and mathematical problems." One aspect of connections is the application of mathematics to every-day situations. While most textbooks include many word problems, the problems are often unfamiliar and irrelevant to the lives of the students. Students need familiar relevant examples of real-world applications of algebraic concepts. The second facet of connections is that students should be able to translate within mathematics, including translation among different representations of algebra concepts.

A year-long project was planned to assist twenty in-service teachers in developing knowledge of these components of effective mathematics teaching methods (cooperative group learning, problem solving, technology, and connections), and in planning and implementing lessons in their pre-algebra and algebra classes.

Technology Components of FAST

Technology is the ideal representation for algebraic relationships. While there has been some discussion of whether graphing calculators or computers are the better technology tools for high school mathematics, this project took the position that both are extremely desirable and the best learning environments are those which utilize all types of technology in appropriate and interesting modes. In addition to being instructionally appropriate, this use of technology is a reflection of the workplace for which these students are ultimately being prepared. Graphing calculators are an essential tool in the algebra classroom, but the use of graphing calculators does not preclude the importance of powerful computer programs in algebra instruction. Thus, the teachers' workshops included both the use of the graphing calculator and the use of algebra computer software programs.

The graphing calculator is quickly becoming a require-



y = 3x-2

x	y
-4	-14.0
-3	-11.0
-2	-8.0
-1	-5.0
0	-2.0
1	1.0

Figure 1. Example of a Network from *Connections.*

ment in high school mathematics classes. The TI-81 is the graphing calculator of choice for teaching algebra here, and this school district purchased several classroom sets for each school. Other brands and models can also be used very effectively. The key utility of this technological tool in an algebra class is function graphing, including the ability to TRACE a function and identify x and y coordinates. Other effective applications include matrix operations for solving simultaneous equations and various statistical analyses. This fundamental tool can be used by teachers in demonstrating, and, more importantly, by individual students and groups of students in manipulation of algebraic data. The workshop sessions involved active participation of the teachers in group problem solving of real-life situations using the graphing calculator as a tool. In this manner, the teachers were instructed and convinced through their own experience of the value of these methods.

The computer supports equally valuable, but different, instructional activities. The Wings for Learning *Connections* software is a simple program that enables the student to build a networked system where translation activities are clearly represented. For example, a table might be the initial representation. The student would then be able to connect this table to an equation structure, which would write the equation, and to a graph which would graph the relationship. These three structures would be connected by "data lines" and change in any structure would result in corresponding changes to the other structures in the network. The student then can physically see the connections of the various representations. It is recommended that this activity be used with a writing assignment where the student writes about the relationship of the various parts of the model.

Other programs such as *The Factory*, *The Pond*, and *The King's Rule* (all of these programs are available from Wings for Learning) can provide group and individual experience in problem solving and critical thinking skills that are important prerequisite skills for algebra students. *Green Globs* is an old, but still exciting and effective, game where students compete by writing equations whose graphs pass through "globs" that are randomly placed on a grid.

Again, the inservice sessions involved active participation of the teachers in use of these software applications. It is not enough that they learn about the teaching strategy; they must also experience the activity to be convinced of its value. This is much like the need for students to actively be involved with the mathematical concept in order to construct an internal meaning. This type of inservice workshop involves a constructivist approach to professional development.

Outcomes of the Project

The twenty teachers who participated in the FAST Project reported improved awareness of current instructional methods. Post-project measures of knowledge of instructional strategies were significantly greater than the pre-project measures. Perhaps the most significant outcome of the project was the teachers' report of increased enjoyment in teaching algebra. When the teachers feel good about what and how they are teaching, they will be more likely to continue utilization of that methodology.

Data in the form of class logs and evaluation visits verified that the teachers frequently used technology in their algebra classes. While there was still some lecture, the teachers made a conscious effort to include some technology activities at least once a week. Usually these activities were implemented as group projects and were combined with problem solving and application connections.

A typical lesson might involve a problem of projection of farm productivity, given data from the past five years. Groups would solve the problem using graphing calculators and presenting their results to the class in the form of graphs and verbal forecasts. These activities frequently would also include background research and discussion and/or writing about the problem. In this rural community, teachers and students were familiar with the farming context. Thus, it provided a viable connection between a real-life application and the mathematics.

Another typical lesson would ask groups of students to use the *Connections* software to produce a model to explain the difference between positive and negative slope in an equation. They would then present their model in poster form to the class and discuss it in terms of real-life applications. This type of project required the students to utilize the computer software as a tool to help them in organizing their knowledge and communicating this knowledge to their peers.

Both of the above examples show the strong emphasis on understanding. Students are no longer allowed to just manipulate the algebraic symbols; they are expected to interact with the algebraic concepts in a significant manner. Using technology tools, they are freed from the tedium of cranking out an answer, and are able to concentrate on understanding the concepts and discussing them in terms of relevant connections.

Student achievement data are not yet available, but informal observations indicate that students are progressing well. They are involved in the class activities because the material is relevant and interesting to them. They enjoy the use of calculators and computers, and understand and appreciate their use as mathematical tools.

Credits

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Evolution of Mathematics Teachers' Attitudes, Instructional Practices, and Concerns about Teaching with Calculators

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Research indicates that the implementation of calculators in mathematics instruction is dependent on both teachers' attitudes toward learning with calculators and teacher involvement in the development of calculator-rich mathematics curricula. Copley, Williams, Huang, and Waxman (in press) found that a two-day in-service training for middle school mathematics teachers did little to affect the implementation of calculators in the teachers' classes but that "teacher involvement in the writing of technology-based curriculum seems to have had a much greater impact." In that study selected teachers worked over an eight-month period developing and field-testing a set of mathematical explorations that required the use of a calculator.

In this paper we report the impact of two calculator in-service projects on (a) teachers' attitudes, (b) teachers' instructional practices, and (c) teachers' evolving concerns about teaching mathematics with calculators. One project was designed to provide, for elementary school teachers, in-service education on (a) regular four-function calculators, (b) algebraic operating system (AOS) four-function calculators, and (c) fraction calculators. The goal of the second project was to provide inservice education on fraction and scientific calculators for mathematics teachers in grades 6-8. These two calculator in-service projects were designed to place greater emphasis on an initial in-service component and less emphasis on a long-term writing component than found in the study reported by Copley et al. (in press).

Project Objectives

The main objective of these projects was to improve teachers' knowledge of how to use calculators to teach mathematics. In order to attain this objective, activities in the 50-hour summer workshop and a 5-hour follow-up workshop were designed to (a) improve the teachers' own skill at using calculators to solve problems, (b) generate teachers' positive attitudes toward calculator use in the classroom, and (c) help teachers develop effective teaching techniques for integrating calculators in mathematics instruction. The National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards* (1989) and NCTM *Professional Standards* (1991) were used as a framework for all activities. Particular emphasis was placed on problem solving, communication, mathematical reasoning, mathematical connections, worthwhile mathematical tasks, learning environment, student discourse, effective use of calculators, effective use of manipulatives, and assessment. These calculator projects had an underlying goal of helping improve teacher's knowledge of what mathematics is important to teach and how to teach mathematics effectively.

Methods

Sample

Eighteen teachers participated in the elementary school project. For the duration of the project the participants taught first grade (1), first/second combination (1), second grade (1), third grade (5), third/fourth combination (1), fourth grade (4), fifth grade (1), fifth/sixth combination (1), and sixth grade (2). One participant served as a K-5 resource teacher for learning disabled and educable mentally handicapped students. Except for the resource teacher, the participants taught in self-contained classrooms. The teachers represented 17 schools in 8 school districts.

Sixteen teachers participated in the middle school project. Eight of the participants taught only mathematics classes. The other participants taught at least one mathematics class daily along with some combination of science, social studies, communications, reading, and language arts classes. The teachers represented 16 schools in 7 school districts.

Measures

Teacher Attitude Scale. A 40-item "Calculator Attitude Scale," adapted from Bitter's (1980) Pocket Calculator Attitude Scale and the scale used by Copley et al. (in press), was administered at the beginning of the first day of the summer course, at the end of the last day of the summer course, and at the end of the follow-up workshop. This scale was designed to assess changes in both teachers' attitudes toward the use of calculators in general and toward the appropriateness of students' using calculators to learn mathematics. The participating teachers indicated their level of agreement with each item by answering either strongly disagree (1), disagree (2), not sure (3), agree (4), or strongly agree (5) to each item. Copley et al. (in press) reported that the modification of the scale used in their research was reliable (r=.95) and valid.

Instructional Practices. Attempts to integrate calculators into mathematics instruction were documented in part by the project instructor during classroom visitations. Additional information on teachers' instructional practices involving calculators was provided by (a) group projects during the summer course and (b) self-reports in the form of journal entries documenting use of calculators in mathematics instruction and assessment between the end of the summer workshop and the follow-up workshop.

Teachers' Concerns. During the follow-up workshop, teachers were introduced to the CBAM model (Hall & Hord, 1987). The teachers then completed a writing assignment designed as a self-assessment of their changes in thinking regarding teaching mathematics with calculators.

Procedures

Summer Course. During the first week of the two-week in-service for elementary school teachers, the workshop sessions focused on participants learning keystrokes on the TI-108, TI Math Mate, and TI Math Explorer calculators while engaged in problem-solving activities; becoming familiar with research results related to student learning with calculators; and planning mathematics instruction with calculators. The planning portion incorporated a study of (a) NCTM's (1989) problem-solving, communication, mathematical reasoning, and mathematical connections standards; (b) NCTM's (1991) worthwhile mathematical tasks, learning environment, discourse, and assessment standards; (c) Berlin and White's (1987) model for incorporating calculators in mathematics instruction; and, (d) NCTM's (1989) standards related to using technology and manipulatives to teach content within specific mathematics strands (i.e., using calculators to develop number sense, number systems, patterns and functions, etc.). The first week of the middle school in-service was similarly structured, with one exception — the calculators used in this in-service were the TI Math Explorer and TI-34 scientific calculators.

During the second week of both summer courses, teachers worked in small groups to develop lesson plans that effectively incorporated calculators in mathematics instruction. Each group presented its lesson to the class, and copies of all lesson plans were distributed to each participant. Each lesson plan and lesson presentation were assessed by the project instructor, other members of the class, and self-assessed by the presenting group. The instructor and each group responded strongly disagree (1), disagree (2), not sure (3), agree (4), or strongly agree (5) to each item on the 10-item lesson assessment instrument. The items addressed the extent to which the given lesson effectively incorporated problem solving, communication, mathematical reasoning, mathematical connections, worthwhile mathematical tasks, learning environment, discourse, calculators, manipulatives, and assessment.

Between the Summer Course and the Follow-up Workshop. During the time between the end of the summer course and the follow-up workshop, teachers maintained a brief journal documenting their use of calculators in mathematics instruction.

Follow-up Workshop. In the 5-hour follow-up workshop, teachers shared journal entries and, in some cases, handouts they designed to use with students. The CBAM model was presented to the participants, and they were given the opportunity to self-assess their concerns (a) at the beginning of the summer course, (b) at the end of the summer course, and (c) currently. The participants were then asked to identify items on the "Calculator Attitude Scale" that they felt would be of highest concern to other mathematics teachers in their school. Based on the items identified, the participants constructed preliminary plans for helping other teachers in their schools more effectively incorporate calculators in mathematics instruction.

After the Follow-up Workshop. The project instructor visited classrooms of 15 teachers in the elementary school project and 12 teachers in the middle school project. During the visits, the instructor observed mathematics lessons involving calculator use by students. These lessons were assessed using the same 10-item lesson assessment instrument used in the summer course.

Results of the Study

Teacher Attitudes. The responses of both groups of teachers at each administration of the Calculator Attitude Scale are summarized in Table 1 as means along with corresponding standard deviations.

Instructional Practices. The detailed results based upon classroom visitations, group projects during the summer course, and self-reports in the form of journal entries are too extensive to be included in this paper. A detailed report is available upon request.

Teachers' Concerns. The results of the self-assessment writing assignment, framed within the CBAM model, are summarized in Table 2.

Discussion

Teacher Attitudes. In general, a comparison of the means in Table 1 indicates that if teachers disagreed with an item, they disagreed more strongly as the project continued. Similarly, if they agreed with an item, they agreed more strongly with time. Attitude changes were indicated predominately on items related to the relationship of calculator usage to paper-and-pencil algorithms, mental computational skills, and memorization of basic facts.

Instructional Practices. During the summer workshop, teachers carefully constructed lessons involving calculator activities that are closely aligned with the NCTM *Standards*. However, both journal entries and classroom observations indicated that the lesson planning model developed in the summer course was not transferred to classroom practice by a majority of the teachers. Basically, those teachers who began the project with a strong commitment to teaching mathematics conceptually embraced the planning model and implemented calculators in mathematics instruction effectively. The teachers who began the course with a limited view of mathematics as a collection of procedures struggled to incorporate calculators in lessons.

Teachers' Concerns. Teachers' concerns about the performance of their students on the calculator portion of the State's new end-of-course tests were largely responsible for the teachers' decision to enroll in these projects. These concerns correspond roughly to the informational and personal levels of the CBAM model. Participation in the project was accompanied by receipt of a classroom set of calculators for each teacher. Possession of the calculators created a wave of management level concerns, especially as

Table 1
Teachers' Responses on the Calculator Attitude Scale in Means

Item	ES-1	ES-2	ES-3	MS-1	MS-2	MS-3
Calculators should be an integral part of the curriculum.	4.22	4.83	4.93	4.29	4.88	4.88
	(1.20)	(1.19)	(1.29)	(.59)	(.33)	(.34)
Calculators are too expensive for classroom use.	1.78	1.39	1.29	1.88	1.65	1.38
	(1.22)	(.85)	(.90)	(.86)	(.70)	(.50)
I want calculators for all students.	4.83	4.94	4.93	4.76	4.82	4.75
	(1.47)	(1.47)	(1.61)	(.44)	(.39)	(.58)
Students should not use calculators if they know how to work the problem using a paper-and-pencil technique.	1.56	1.40	1.64	1.71	1.76	1.69
	(1.01)	(.98)	(1.15)	(.47)	(.97)	(.70)
I need to know better ways to incorporate calculator use into the mathematics curriculum.	4.78	3.61	3.86	4.71	3.21	4.06
	(1.74)	(1.75)	(1.88)	(.47)	(1.12)	(.44)
Students should not be allowed to use calculators while taking math tests.	2.22	1.89	1.43	1.88	1.82	2.25
	(1.08)	(1.28)	(.81)	(.60)	(.81)	(1.13)
I have a growing appreciation of calculators through understanding their application to the school curriculum.	4.00	4.72	4.79	4.18	4.65	4.75
	(1.28)	(1.18)	(1.28)	(.39)	(.49)	(.45)
Calculators should be used for homework but not for classwork.	1.72	1.56	1.43	1.59	1.59	1.50
	(1.01)	(.85)	(.94)	(.51)	(.51)	(.52)
Extensive use of calculators in mathematics programs makes estimation an increasingly important skill to be taught.	3.78	4.56	4.57	4.24	4.56	4.38
	(1.50)	(1.60)	(1.78)	(.75)	(.51)	(.62)
I am hesitant to use calculators with students because of my limited understanding of the devices.	2.94	1.78	1.50	2.41	1.65	1.81
	(1.60)	(1.22)	(1.33)	(1.00)	(.49)	(.54)
Calculator use causes a decrease in basic computation skills.	2.22	1.67	2.00	2.71	2.06	2.13
	(1.15)	(1.08)	(1.29)	(.77)	(.66)	(.72)
I would prefer to use a classroom set of calculators than to issue a calculator (like a textbook) to each child.	3.39	2.56	2.21	2.82	2.88	2.75
	(1.62)	(1.58)	(1.53)	(1.47)	(1.36)	(1.44)
I do not feel calculators should be allowed in the schools.	1.39	1.18	1.50	1.29	1.47	1.31
	(.61)	(.54)	(1.08)	(.47)	(1.01)	(1.01)
Calculators make more mathematics content teachable through the use of student exploration.	4.17	4.83	4.57	4.18	4.29	4.38
	(1.21)	(1.18)	(1.50)	(.64)	(.99)	(.50)
Students should be able to work problems using paper-and-pencil techniques before being allowed to use calculators.	2.94	2.11	1.64	2.94	2.41	2.31
	(1.37)	(1.11)	(1.27)	(1.14)	(.87)	(.95)
Calculator use provides fewer opportunities for students to develop mental computation skills in school.	2.33	1.67	1.46	2.35	1.76	2.00
	(1.15)	(1.08)	(1.00)	(.86)	(.66)	(.73)
Calculators can stimulate a child to study mathematics.	4.08	4.78	4.86	4.12	4.65	4.44
	(1.30)	(1.33)	(1.46)	(.33)	(.49)	(.51)
Calculators should be used as an aid in computation.	4.00	3.89	4.43	3.67	4.41	4.31
	(1.20)	(1.50)	(1.50)	(.83)	(.62)	(.48)
Mental computation skills should continue to be taught when calculators are used extensively in mathematics programs.	4.39	4.78	4.50	4.59	4.53	4.56
	(1.67)	(1.76)	(1.86)	(.51)	(.62)	(.81)
Problems with distribution, upkeep, and security of calculators make them more trouble than they are worth.	1.72	1.39	1.29	2.18	1.47	1.44
	(.57)	(.50)	(.49)	(.61)	(.51)	(.51)
I am not certain of the most effective way to teach with calculators.	3.67	1.83	1.71	3.59	2.00	2.44
	(1.53)	(1.37)	(1.14)	(1.06)	(.50)	(.89)

continued on next page

Table 1(continued from previous page)

Answers should be estimated before being computed with a calculator.	3.72 (1.43)	2.75 (1.47)	3.29 (1.54)	3.29 (1.21)	3.36 (1.11)	3.40 (1.12)
Calculators should be used to lessen the need for memorization.	2.78 (1.24)	2.56 (1.19)	3.50 (1.29)	2.82 (1.07)	3.47 (.80)	3.07 (.96)
Calculators should be used as a substitute for the development of computation skills.	1.90 (.73)	1.38 (.86)	1.93 (1.14)	1.47 (.51)	1.65 (.61)	1.53 (.52)
I think calculators confuse and inhibit students' learning of mathematics.	1.94 (.99)	1.69 (1.43)	1.36 (1.08)	1.94 (.66)	1.41 (.51)	1.47 (.52)
Calculators are tools that allow students to focus more attention on mathematics concept development and understanding.	3.72 (1.64)	4.81 (1.53)	4.79 (1.58)	4.18 (.53)	4.47 (.61)	4.40 (.51)
Using calculators helps students learn, retain, and internalize number facts.	3.39 (1.27)	4.06 (1.63)	4.14 (1.58)	3.89 (.82)	4.00 (.79)	3.67 (.82)
Students use more varied problem-solving strategies when using calculators.	3.94 (1.23)	4.94 (1.23)	4.71 (1.20)	3.88 (.60)	4.36 (.49)	4.33 (.49)
Lack of instructional time makes it difficult to introduce and use calculators.	2.78 (1.37)	1.63 (.89)	2.07 (1.43)	2.59 (1.10)	2.00 (.87)	2.33 (1.18)
I feel adequately prepared to use calculators while I instruct.	3.06 (1.29)	4.13 (1.38)	4.21 (1.27)	3.18 (1.07)	4.18 (.39)	3.93 (.59)
Adequate teaching materials for calculator classroom use are not available.	3.28 (1.65)	2.69 (1.45)	2.21 (1.47)	2.53 (.94)	2.95 (1.06)	2.20 (1.01)
It is all right for students to use calculators to solve problems that they do not know how to work using paper-and-pencil techniques.	3.50 (1.64)	4.44 (1.77)	4.86 (1.84)	3.35 (1.37)	4.18 (.73)	2.93 (.88)
The teacher should determine when calculators should be used in class.	3.78 (1.49)	3.53 (1.59)	1.79 (1.25)	4.06 (.66)	3.41 (1.23)	3.47 (1.30)
Calculators should be used as an aid in exploring, understanding, and learning algorithmic processes.	4.17 (1.21)	4.75 (1.38)	4.79 (1.45)	4.24 (.56)	4.31 (.79)	4.40 (.51)
Students who use calculators understand mathematics better than those who do not use them.	3.06 (1.08)	3.63 (1.27)	4.29 (1.45)	2.88 (.49)	3.53 (.62)	3.00 (.76)
Extensive calculator use will negatively affect a student's mathematics thinking ability.	2.39 (1.25)	1.56 (.94)	1.50 (1.29)	2.18 (.73)	2.24 (1.15)	1.93 (1.03)
Students should completely master the basic facts in mathematics before using calculators.	2.53 (1.31)	1.81 (1.08)	1.29 (1.10)	3.06 (1.30)	2.29 (.85)	1.73 (.70)
I need additional training in ways to assess student learning with calculators are present.	4.44 (2.01)	3.13 (1.83)	2.86 (2.15)	4.19 (.98)	3.06 (.85)	3.47 1.06
My feelings about calculator use in schools have become more positive in the past few years.	4.28 (1.25)	4.75 (1.38)	4.79 (1.45)	4.47 (.51)	4.53 (.51)	4.67 (.49)
A great deal of instructional time is needed at the beginning of the school year to teach the use of all the calculator keys.	2.67 (1.39)	2.19 (1.09)	1.79 (1.34)	2.99 (1.05)	2.35 (.79)	2.13 (.64)

Note: ES-1, ES-2, and ES-3 indicate the first, second, and third administrations of the scale in the elementary school project. MS-1, MS-2, and MS-3 refer analogously to the three administrations in the middle school project.

Table 2
Summary Analysis of Teachers' Responses to CBAM Writing Assignment in Percentages

	Elementary School Teachers			Middle School Teachers		
CBAM Level	First	Second	Third	First	Second	Third
0 - Awareness	14	0	0	12	0	0
1 - Informational	64	0	0	87	0	0
2 - Personal	50	43	0	56	50	19
3 - Management	0	71	7	6	44	44
4 - Consequence	0	50	64	6	37	62
5 - Collaboration	0	0	79	0	6	31
6 - Refocusing	0	0	14	0	0	0

Note. Each response was classified into one or more CBAM levels so that the total percentage for any one administration exceeds 100%.

the teachers faced the beginning of a new school year. Concerns about how calculators would affect student learning were apparent throughout the project but became more focused as teachers began to observe students in the implementation stage. By the time of the follow-up workshop, teachers were anxious to collect calculator activities and share their calculator activities with others. Several had arranged to provide in-service calculator workshops for other teachers in their building.

Closing Comments. The two in-service projects presented here, unlike the much shorter in-service reported by Copley et al. (in press), appear to have positively affected the implementation of calculators in the participants' classes. This positive effect may be attributed, in part, to the significant writing component incorporated in the summer course. This conclusion is consistent with the conclusion (Copley, et al., in press) that teacher involvement in writing technology-based materials is an important factor in implementation of calculators in classrooms.

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Is Experience Enough?: A Survey of Mathematics Teachers' Philosophies of Calculator Use

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Mathematics education reform efforts are guided by two different, opposing theories. According to Linda Darling-Hammond (1993), proponents of the first focus on the "basics"and favor more direct instructional practices. Advocates of the second emphasize "capacities of teachers and ... the development of schools as inquiring, collaborative organizations" (Darling-Hammond, 1993, p. 755).

How do teachers with these perspectives view calculator use in mathematics teaching and learning? Although educational reform literature addresses the importance of teacher beliefs, attitudes, and knowledge (Clark & Peterson, 1986; Fennema & Franke, 1992; Thompson, 1992), reform efforts encouraging the use of technology must consider fundamental differences in teachers' philosophical perspectives.

This investigation considered responses of 94 middle school and secondary mathematics teachers on the researcher designed Attitude Instrument for Mathematics and Applied Technology (AIM-AT). (See Figure 1.) Guiding questions were:

1. What attitudes do teachers have concerning the use of calculators in mathematics teaching and learning?
2. Do teacher responses to AIM-AT items suggest two opposing philosophies of mathematics instruction?
3. If two opposing philosophies of mathematics instruction exist, what differences in beliefs about the use of calculators in the teaching and learning of mathematics occur between these two groups?

Methods

This section includes a discussion of subjects, instrumentation, and procedures.

Subjects

During the annual meeting of the Oklahoma Council of Teachers of Mathematics (OCTM), over 100 middle school and high school teachers participated in four two-hour calculator workshops and received instruction on the CASIO 7000 Overhead Projectable Graphing Calculator. Most of participants were Caucasian/Non-hispanic, all indicated some prior personal use of calculators and 76% reported using calculators in math teaching at least once a week.

Instrumentation

The AIM-AT was adapted from the calculator use attitude instrument reported in Huang (1993). It consisted of 23 items with Likert-type forced responses on a four point scale. (See Figure 1.) The validity of many of the items has been reported in Bitter and Hatfield (1992). Three categories of items were identified: (a) beliefs about the cognitive effects of calculator use, (b) experience with and personal use of calculators in teaching, and (c) beliefs about affective results of using calculators in mathematics teaching. (See Figure 2.) Internal reliability for the AIM-AT using Cronbach alpha was 0.49.

Procedures

Four two-hour sessions were scheduled during the two day OCTM conference. Approximately 25 teachers

		Agree/ Strongly Agree	Disagree/ Strongly Disagree
1.	Students should not be allowed to use a calculator while taking math tests.	31%	69%
2.	Calculator use will cause a decline in basic arithmetic facts.	37%	63%
3.	Calculators are motivational.	94%	6%
4.	Calculators make mathematics fun.	89%	11%
5.	When students work with calculators, they don't need to show their work on paper.	14%	86%
6.	Math is easier if a calculator is used to solve problems.	71%	29%
7.	More interesting mathematics problems can be done when students have access to calculators.	95%	5%
8.	Students understand math better if they solve problems using paper and pencil.	31%	69%
9.	Students should not be allowed to use calculators until they have mastered the concept or procedure.	49%	51%
10.	All students should learn to use calculators.	97%	3%
11.	Using calculators will make students try harder.	70%	30%
12.	Calculators should be used only to check work once the problem has been worked out on paper.	19%	81%
13.	Calculators should be used on math homework.	84%	16%
14.	Using calculators will cause students to lose basic computational skills.	33%	67%
15.	Using calculators makes students better problem solvers.	79%	21%
16.	Continued use of calculators will cause a decrease in student estimation skills.	28%	72%
17.	I have calculators available for my class(es) to use.	72%	28%
18.	Most of my students have access to their own calculators.	70%	30%
19.	Calculators are only tools for doing calculations more quickly.	45%	55%
20.	I have used graphing calculators in my classroom before.	29%	71%
21.	I am proficient at using scientific calculators.	52%	48%
22.	I know ways I can use the calculator effectively in my classroom.	69%	31%
23.	I have lots of ideas about how I can make use of this calculator.	60%	40%

Figure 1. Teacher Responses to AIM-AT Survey.

Category 1: Cognitive

Beliefs about effect and appropriate use of the calculator.
Items: 1, 2, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 19

Category 2: Experiential

Experience with and use of calculators in teaching.
Items: 17, 18, 20, 21, 22, 23

Category 3: Affective

Beliefs about affective results of using calculators in the classroom.
Items: 3, 4, 7, 11

Figure 2. AIM-AT Categories.

participated in each session. Four presenters, including the researcher, individually coordinated the workshop sessions. As workshop materials were distributed and before instruction began, teacher-participants were asked to fill-out the AIM-AT survey and participant tracking forms. Sixty-nine women and twenty five men completed the AIM-AT survey. Although participation by completing the survey was optional, over 90% of the participants returned their AIM-AT questionnaires to the session presenters.

Analyses

Consensus items were defined by over 70% agreement or disagreement responses on the AIM-AT and were used to answer research question one. Philosophical differences were identified by responses to the AIM-AT statement "students should not be allowed to use calculators until they have mastered the concept or procedure" (item 9). Previous research (Darling-Hammond, 1993, Fleener & Nicholas, in press) suggested opinions would be divided on this item. Separate single factor ANOVAs were performed to determine whether responses to item 9 significantly effected responses to other AIM-AT statements. Post hoc analyses using Scheffe F-test determined significance at the .05 level. These results were used to answer research questions two and three.

Results and Discussion

Question 1: What attitudes do teachers have concerning the use of calculators in mathematics teaching and learning?

Consensus items from the cognitive category (5, 6, 10, 11, 12, 13, 15) indicate beliefs that students should learn to use calculators and have them available for use. Paper-and-pencil computations are not required when students work with calculators and benefits of calculator use include better problem solving without a decline in estimation skills. Consensus on experiential items (17, 18, and 20) indicate the teachers had common experience with and used calculators in teaching. Consensus items in the affective category indicate agreement concerning the motivational (items 3 and 4) and psychological (items 7 and 11) benefits of calculator use for students. (See Figure 3.)

Every category 3 (affective) item was consensual and experiential differences indicated degrees in confidence. Philosophical differences are demonstrated by responses to item 9 as described below.

Question 2: Do teacher responses to AIM-AT items suggest two opposing philosophies of mathematics instruction?

As expected, teachers were divided in responses to item 9 on the AIM-AT. Forty-nine percent agreed "students should not be allowed to use calculators until they have mastered the concept or procedure." ANOVA results revealed statistically different responses on 8 AIM-AT items between teachers who agreed (mastery-group) and disagreed (non-mastery group) with item 9 (see Figure 4). Further examination of these items will provide the answer for question 3.

Factor	Item	Percent	Type
3	3	94	Agree
3	4	89	Agree
1	5	86	Disagree
1	6	71	Agree
3	7	95	Agree
1	10	97	Agree
3	11	70	Agree
1	12	81	Disagree
1	13	84	Agree
1	15	79	Agree
1	16	72	Disagree
2	17	72	Agree
2	18	70	Agree
2	20	71	Disagree

Figure 3. Consensus items defined as agreement/disagreement greater than or equal to 70%.

Question 3: If two opposing philosophies of mathematics instruction exist, what differences in beliefs about the use of calculators in the teaching and learning of mathematics occur between these two groups?

Separate analysis of variance on cognitive items indicated statistically significant differences between groups on items 2 (*F*=18.512, *df*=1/90, p=.0001), 8 (*F*=8.411, *df*=1/92, p=.0047), 12 (*F*=17.826, *df*=1/92, p=.0001), 13 (*F*=4.899, *df*=1/91, p=.0294), 14 (*F*=9.937, *df*=1/91, p=.0022) and 15 (*F*=7.834, *df*=1/91, p=.0063). Even though item 19 does not show statistical difference, 54% of the mastery group agrees calculators are only tools for doing calculations more quickly while 65% of the non-mastery group disagreed. The wide variance of responses to item 19 indicates teachers lack a clear vision of multiple applications and uses of the calculator. Statistical significance on items 7 and 15 reinforces the mastery group lacks a clear vision of non-computational calculator use. These findings are consistent with results of a case study of preservice teachers (Fine & Fleener, in press).

Statistical differences on items 2, 8, 12 and 14 suggest a philosophical difference between the mastery and non-mastery groups regarding the role of computation in learning mathematics. The mastery group believed working problems on paper is essential for conceptual understanding and over-reliance on the calculator will cause a decline in computational skills while the non-mastery group disagrees with these statements.

Analysis of variance on items from the experiential category do not reveal a difference between groups based on the mastery issue, indicating experience may not be related to beliefs about the mastery of concepts and procedures. This suggests experience with calculators is not sufficient for challenging beliefs related to the importance of concep-

Category	Item	F-value	p-value	Mastery-Gp-Resp#	Non-Mastery-Gp-Resp
Cognitive	1	2.9090	.0915	61% disagree	77% disagree
Cognitive	2	18.512	.0001**	53% agree	79% disagree
Cognitive	5	0.4010	.5280	87% disagree	85% disagree
Cognitive	6	1.2700	.2626	67% agree	75% agree
Cognitive	8	8.4110	.0047**	52% disagree	85% disagree
Cognitive	10	0.4280	.5145	98% agree	96% agree
Cognitive	12	17.8260	.0001**	67% disagree	94% disagree
Cognitive	13	4.8990	.0294*	78% agree	90% agree
Cognitive	14	9.9370	.0022**	52% disagree	81% disagree
Cognitive	15	7.8340	.0063**	67% agree	90% agree
Cognitive	16	3.0090	.0861	67% disagree	77% disagree
Cognitive	19	3.0230	.0854	54% agree	65% disagree
Affective	3	2.6410	.1075	89% agree	98% agree
Affective	4	0.6180	.4337	87% agree	92% agree
Affective	7	6.2230	.0144*	91% agree	98% agree
Affective	11	6.3300	.0136*	54% agree	85% agree
Experiential	17	0.2750	.6012	74% agree	70% agree
Experiential	18	1.6610	.2008	69% agree	72% agree
Experiential	20	0.4120	.523	68% disagree	75% disagree
Experiential	21	0.0400	.8423	55% agree	50% split
Experiential	22	2.5020	.1176	63% agree	76% agree
Experiential	23	0.4190	.5192	56% agree	64% agree

+	*n*=94 for most items
#	Majority response for mastery/non-mastery groups
*	Significant at .05 level
**	Significant at .01 level

Figure 4. One factor ANOVA: Mastery (item 9) by AIM-AT Items+.

tual/procedural mastery before calculators are used.

Significance

Lieberman and McLaughlin (1992) have noted the general failure of traditional in-service attempts to affect permanent curricular reform. Many change models consider the importance of prior values, beliefs, attitudes, and knowledge (Hord, Rutherford, Huling-Austin, & Hall, 1987) but do not delve deeper into teaching philosophies. The relationship between philosophical orientation and beliefs about using calculators in instruction needs to be clear before efforts to change teaching practices by including technology can succeed. This article is an attempt to delineate this relationship.

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Integrating Calculators and Computers into an Elementary Mathematics Education Program

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In this paper I will describe how computer and calculator technology has been integrated into the mathematics content and methods courses in the elementary education program at Wittenberg University. Wittenberg University is a private liberal arts college with an enrollment of approximately 2000 students. The elementary education program at Wittenberg graduates approximately 40 elementary teachers per year. In the elementary education program there is no separate course in technology; instead, use of technology is integrated into most of the courses in the program.

Elementary education majors are required to take two mathematics content courses and one mathematics methods course. Currently, all three of these courses are taught by the author.

There is an Apple IIe computer with a 25-inch color monitor in each of the rooms used by these courses. In addition, there is a computer lab with 13 Apple IIgs computers networked together. The lab has a 25-inch color monitor and a monochrome projection panel used with one of the two overhead projectors in the room. The display from this panel is projected onto a whiteboard (so it is possible to draw on the image displayed). The Apple IIgs computer in the instructor's office is connected to the network.

Mathematics Content Courses

In the first mathematics content course, Mathematics for Elementary and Middle School Teachers, students study number systems, measurement, algebra, logic, probability, and statistics with a special emphasis on problem solving.

Students are required to purchase a Texas Instruments TI-12 Math Explorer calculator. This calculator was designed to be used primarily in the middle grades. It has a number of special features, including standard order of operations, an integer division key, and the ability to work with fractions. The instructor has a matching overhead projector calculator.

Students are given instruction in the use of the calculator and encouraged to use it on homework, quizzes, and tests. The calculator is also used in class activities designed to increase student understanding of the mathematics concepts being taught. The instructor has three primary reasons for requiring students to purchase this calculator.

1. In the interest of fairness, he feels that every student should have the same calculator for quizzes and tests.
2. He wants students to become familiar with the features of a calculator designed specifically for use with elementary and middle school students.
3. He wants to be able to plan lessons based on the knowledge that everyone in the class has the same calculator.

There was some initial concern on the part of some students (and the instructor) about the $25.00 cost of the calculator. However, the investment has proved to be worthwhile. The calculator is an important and frequently used tool in the course.

In this same course, the computer in the classroom or the computer lab is used 5 - 6 times during the term to generate problem solving situations (using either commercial programs or programs written by the instructor). In addition, students use hypermedia stacks (created by the instructor using *HyperStudio* from Roger Wagner Publishing) to review selected concepts in the course.

In the second mathematics content course, Geometry with Logo Programming for Elementary and Middle School Students, students study informal geometry with a special emphasis on the relationship between art and mathematics. (Students are encouraged, and in the near future will be required, to enroll in the Art for Elementary School Teachers course concurrently with this course.)

Students also learn to program in Logo in this course. Logo is a structured, graphics-oriented computer language designed for use with elementary and middle school students. The emphasis in the use of Logo is primarily on applying geometry concepts and on problem solving, rather than on "learning to program." Students turn in two small-group projects for grades. In the first project, they are required to reproduce a tangram design using Logo (including the creation of procedures for each of the tangram pieces). The second project is open-ended; students are asked to "do something interesting" with Logo, while meeting several criteria about the use of graphics and sound. Students invest a great deal of time and energy in the second project; the projects most often are in the form of a game, a story, or an instructional program.

Mathematics Methods Course

The emphasis in the methods course, Teaching Elementary and Middle School Mathematics, is on teaching mathematics for understanding through the use of concrete materials and applications to the real world. The use of calculators in the elementary school is discussed in this course.Several class sessions are spent on classroom computer applications like simulations, tutorial programs, and instructional games. Students are also taught how to create hypermedia stacks using *HyperStudio* and, working in pairs, are expected to create an instructional stack incorporating many of the sound and graphics features of *HyperStudio*. Outside of class, students are required to evaluate several instructional computer programs and to use *Print Shop*.

Conclusion

We feel this integrated approach to the use of computer and calculator technology in the elementary mathematics education program is effective. Not only are students given direct instruction in the appropriate uses of such technology, they also expe*rience* the use of this technology in the courses they are taking. Since teachers often teach the way they have been taught, we hope our graduates will incorporate computer and calculator technology into *their* classrooms.

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Beyond Arithmetic: Calculator Inservice for Mathematics Teachers

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Children learn more effectively by doing rather than by listening, an opinion that is explicitly recognized by the current emphasis on the use of manipulatives and technology in teaching mathematics. Use of technology, including calculators, in teaching mathematics has been encouraged by the National Council of Teachers of Mathematics (1989), the New York State Regents Action Plan (New York State Education Department, 1991), and the New York State Compact for Learning. Calculators are now required for New York State Regents examinations[1] (four function calculators must be made available to all students for mathematics Regents examinations. Scientific calculators are used on the Advanced Placement Calculus exam, and in 1995, graphing calculators will be allowed on the exam.

Calculators can be a powerful and cost-effective tool, used to teach problem solving, to make connections between the concrete and the abstract, and to emphasize conceptual development of numerical relationships. Of course, a calculator can be used merely as a mechanical aid to re-check answers computed manually, but limiting the application of calculators to that purpose is much like using a microwave oven merely to reheat coffee. Unfortunately, many teachers are unaware of the pedagogic possibilities afforded by the use of calculators; they must be trained in their use. All too often, teachers do not have the time to keep up with changing standards that can improve both classroom learning and their teaching methods. Elementary teachers are further handicapped by the breadth of subject matter they are required to teach and by inadequate preparation during their preservice training. Familiarization with, and understanding of new pedagogic techniques and strategies are essential to effective teaching and learning.

Finally, understanding curriculum standards and training in the use of technology and in innovative teaching techniques are not, by themselves, sufficient. No matter how well trained in the use of manipulatives or other technological tools, teachers without access to those tools can not make use of them. Teachers must have access to the materials and resources for their own use in development of lessons as well as in the classroom for implementation of those lessons.

Project TIME (Technology in Mathematics Education) is an effort to alter mathematics instruction at all grade levels by providing teachers with the technological and pedagogical skills and materials they need to alter their teaching strategies; to enhance self-confidence so that they will try new methods; and to develop a peer support network that will be necessary to nurture and facilitate change.

Description of the Program

Project TIME was funded through the Dwight D. Eisenhower program to enhance the teaching of science and mathematics. A $45,000 grant, administered through the New York State Education Department, enabled the co-principal investigators, working collaboratively with personnel from four central New York school districts, to design a multi-faceted program to provide teachers with the means and the training to use calculators effectively in the classroom. At its inception, the co-principal investigators had only a skeleton of the program in mind that is, the framework for effective inservice and support. The decision to focus exclusively upon calculators was made by representatives of the cooperating school districts. Central to the project were three simultaneously running one-week inservice training courses on the use of calculators. These courses were developed by teachers for teachers, at each of three levels, elementary, junior high school, and high school. Specifically, the courses had four objectives. Teachers participating in the project will be able to:

- use calculators appropriately as a tool in mathematics education;
- create a learning environment that encourages students to develop their own problem solving skills;
- understand the NCTM curriculum standards and their relation to the New York State mathematics syllabi;
- access resources to achieve the NCTM standards within their curriculum.

Inservice courses were offered to teams of teachers from five area school districts (the four cooperating districts, and one other district added on a tuition basis) during the last week of June 1993.[2] The workshops were held on the campus of the SUNY Institute of Technology at Utica/Rome. To make certain that lack of equipment would not hamper transfer to the classroom, a substantial portion of the grant funding was used to purchase classroom sets of calculators that went back to the classroom with participating teachers. In addition, some of the participating school districts purchased additional calculators using local funds or donations from Parents Associations and similar groups. In some instances, participating teachers waived the $250 stipend to take additional calculators back to the schools. In other cases, participant stipends were waived to permit the program to accommodate additional applicants; the budget provided for twenty-four participants, and thirty-eight were enrolled. Participants were expected to integrate the use of these calculators into mathematics instruction during the 1993-94 school year. While evaluation of the implementation or final phase of the project is not yet possible, evaluation of the workshop indicates that the project was successful in changing teachers attitudes about calculators and their perceptions of their own skills in using calculators.

Perceptions of Calculator Skills

A post-course evaluation instrument was designed to measure consumer satisfaction and skill levels. After the course, 94% of the participants indicated that they felt that they had mastered the course material; 86% think it will be easier for them to integrate their knowledge into the classroom; 97% found the support materials helpful.

Attitudinal Changes

A two-part, seventy-five item questionnaire was developed to measure attitudes toward calculators and knowledge of NCTM standards. The questionnaire was administered to all participants at the orientation session on the first day of the workshop, and again at the conclusion of the last day. Questionnaires were numbered to permit pairing of pre and post test responses. At the time of the first administration, participants were informed that the exercise would be repeated on the last day. Thirty-six of the thirty-eight participants were present on both days.

The first part of the questionnaire consisted of twenty-five items, nineteen of which were based on the Bitter Pocket Calculator Scale as adapted by Huang, Copley, Williams, and Waxman (1992). The remaining six items were designed to measure attitudes on gender equity and multiculturalism in the mathematics classroom. Respondents were asked to indicate their level of agreement with a series of statements that were phrased both positively and negatively to control for response bias. Responses were coded on a nine point scale (with 1 representing strong agreement, and 9 representing strong disagreement). T-tests were run using paired samples, and the results are presented in Table 1.

On thirteen of the nineteen items adapted from the Bitter instrument, significant improvements ($p<.05$) occurred. The self-selecting nature of the participants, and their inherent interest in calculators may account for the lack of change on several items. Item 17, for example, elicited participant agreement with the statement *Calculators should not be allowed in the schools*. One would hardly expect participants in a course on the use of calculators to substantially agree with that statement; they did not, and the workshop did not substantially alter participant opinion. That statement in the Bitter instrument, however, would be valuable for a wider cross-section of teachers. Other items in the instrument are predicated upon experience in the classroom; completion of a six-month follow-up administration of the questionnaire will permit appropriate analysis.

With respect to the six items on gender equity and multiculturalism in the mathematics classroom, significant results were obtained in only two. The most likely explanation is that two of the workshop groups spent little time addressing these issues; future workshops need to target these issues more directly. The small size of the group that did cover these topics makes meaningful analysis impossible.

The second part of the questionnaire consisted of locally developed items designed to probe knowledge of NCTM standards and their application. Respondents were presented with a series of graphs and geometric shapes and possible questions that teachers might ask students about the graphs or shapes. Teachers were reminded that the sample questions would have to be adapted to grade level, and were asked to examine the graphs or shapes and questions and respond to statements assessing the appropriateness of the sample questions to NCTM standards, to school goals, and their own teaching practice.

With respect to four sample questions requiring higher order thinking skills, significant improvements ($p <.05$) were noted in participants' identification of these questions as consonant with NCTM standards in all cases, and appropriate for their schools' goals in three of the four

Table 1
Pre and Post-test agreement scores

Question	Pre	Post	Diff.	*t*	*p* (one tail)
Calculators should be an integral part of the curriculum	2.59	1.43	-1.16	-5.18	.0000
I get no satisfaction from using calculators	7.30	8.49	1.19	3.50	.0005
I want calculators for all students	1.92	1.27	-0.65	-2.61	.0065
Calculators are too expensive for classroom use	7.59	8.27	0.68	2.04	.0245
Calculators are neat	2.51	1.59	-0.92	-2.58	.0007
The use of calculators for games and fun should be encouraged	2.16	1.92	-0.24	-0.82	.2085
Students should be allowed to use calculators while taking tests	3.24	2.30	-0.94	-3.32	.0001
I have a growing appreciation of calculators through understanding their application to the school curriculum	2.95	1.43	-1.51	-5.44	.0000
I have never liked calculators	8.00	8.08	0.08	0.34	.3690
Working with calculators is fun	2.13	1.54	-0.59	-1.79	.0410
I am afraid to work with calculators and use them in the class with students	7.62	8.21	0.59	1.56	.0635
Calculators will cause students to not understand the basic computational skills	6.54	7.00	0.46	1.17	.1245
Calculators should be available for all students in all grades	2.35	1.71	-0.65	-2.26	.0150
Most schools will have calculators available for students within the next five years	2.84	2.38	-0.46	-1.12	.1345
Working with calculators is boring	8.14	8.51	0.39	.20	.0255
Boys have more mathematical ability than do girls	8.35	8.35	0.00	0.00	.5000
I don't feel calculators should be allowed in the schools	8.59	8.54	-0.05	-0.22	.4135
There is no need to address cultural diversity in the math curriculum	7.00	6.37	-0.63	-1.49	.0730
The use of calculators is causing students to lose the chance to do mental calculations in school	6.53	7.17	0.64	1.74	.0455
Girls are more careful with calculations than boys	6.50	7.61	1.11	3.07	.0020
In teaching, I point out the connections between mathematics and other disciplines	3.17	2.17	-1.00	-2.98	.0025
Using calculators is more fun for boys than for girls	8.25	7.97	-0.28	-1.22	.1150
Calculators can stimulate a child to study mathematics	2.69	1.97	-0.72	-1.97	.0285
Calculators do not allow students to do simple mathematics on paper	7.22	7.69	0.47	1.41	.0835
It is important for students to see multicultural links to mathematics	2.86	3.16	0.30	0.95	.1735

cases. After the workshop, participants indicated that they are more likely to use higher order thinking questions for homework and tests. Here too, changes in attitude were significant for all items measuring higher order thinking skills.

On a series of items designed to elicit teachers' perceptions of their comfort level with higher order mathematics problems, significant improvements were noted in nine of ten items.

Conclusion

Change in the classroom will not occur until teachers are cognizant of newly emerging standards, nor until they possess the skills necessary to comfortably integrate new approaches into the classroom. Project TIME was successful in equipping participants with the attitudes and competencies that will make it possible to integrate the use of calculators in the classroom. An important component of the program was its early reliance upon teachers from the cooperating districts in all facets of the project design, scheduling, budgeting, and participant selection. Project TIME was not an example of university personnel telling teachers what they needed; it was a collaborative project that illustrates potential for educational change where a true partnership flourishes.

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[1] New York State has statewide examinations, called Regents Examinations, for most college preparatory courses. Students seeking to earn a state recognized Regents diploma are required to pass a distribution of courses and Regents Examinations to earn that diploma.

[2] Participating school districts were Cherry Valley/Springfield Central Schools, Holland Patent Central Schools, Sauquoit Valley Central Schools, Utica City School District, Whitesboro Central Schools, and the Whitesboro Teacher Center.

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Calculator Use in a Summer Pre-algebra Program

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This paper presents a description of one high school district's initial attempts at reforming their mathematics curriculum. The reform process included the implementation of an intensive summer Pre-algebra Academy for incoming ninth graders. The goal of the Academy was to prepare incoming freshman, who previously had been placed in either Pre-algebra or general mathematics, for placement in Algebra, instead. A major element of the reform process was the purchase of calculators that were made available to students in the summer program and would remain available to them throughout their entire high school careers.

Calculators in Mathematics Education

The notion of providing students with calculators for mathematics classes is not new. Since the appearance of pocket calculators in the early 1970s, mathematics educators have been aware of the potential of calculators for changing the focus of mathematics instruction. As early as 1973, Hawthorn, believing that pocket calculators would soon become commonplace, proposed that calculators would change the focus of mathematics from lengthy arithmetic calculations using paper and pencil, to understanding the concepts of arithmetic.

As calculators became more available in classrooms, their future looked promising. Wheatley (1980, p. 620) realized that, "Calculators have the potential of reshaping the mathematics curriculum in our schools." Bitter (1980, p. 323) observed that "...student use of calculators within the classroom is increasing. [D]ue to the increasing endorsements by teacher educators, teaching organizations, and textbook publishers, it appears that their use will continue to increase."

As the use of calculators increased in homes and businesses, researchers investigated the effects of classroom calculator use on mathematics achievement and on students' attitudes toward mathematics. Although individual studies had varying results, Hembree and Dessart (1986), using meta-analysis techniques on 79 studies conducted from 1969 through 1983, found strong evidence supporting calculator use. They concluded that at all grade levels K-12, except the 4th grade, calculators improved paper and pencil skills in computation and improved skills in problem solving. In addition, they found that calculator use was associated with both improved attitudes toward mathematics and improved self-concept.

The evidence supporting the benefits of calculator use was powerful and the National Council of Teachers of Mathematics (NCTM) repeatedly endorsed the integration of calculators into mathematics instruction. The NCTM supported calculator use at all grade levels in *An Agenda for Action* (1980), a position statement about calculators in the classroom (1987), and in the *Curriculum and Evaluation Standards for School Mathematics* (1989). In all three communications, NCTM suggested that calculators in the classroom could reduce the time students spent on practicing paper and pencil calculations. The time gained could be spent on developing an understanding of concepts, reasoning, and problem solving skills, as well as using and applying mathematics in more realistic situations. Nonetheless, curricular change is slow and changes in mathematics instruction are no exception. Calculator use has not proliferated in the classroom despite the conviction that calculators should be accessible to all students because of their demonstrated benefits and the continued and repeated support of the NCTM.

Results of the International Assessment of Educational Progress indicated that although 89% of 13 year old students questioned owned a calculator, only 54% of them had ever used a calculator in the classroom (Educational Testing Service, 1992). The Educational Testing Service (ETS) (1992, p. 56) report stated that, "[calculators] were not yet a part of regular [classroom] instruction." Loyd (1990) found a less encouraging pattern when studying calculator use with high school students. Of the students surveyed only 16% reported daily use, 14% weekly use, and 14% monthly use. About 50% of the high school students surveyed almost never used calculators in their classes. Recommendations of the NCTM may have been heard. Zambo (1993a) found that 61% of 7-8 grade teachers questioned agreed that calculators are a useful tool for problem solving. Nevertheless, it appears that the recommendations have gone unheeded, only 26% of same teachers agreed with a statement that they allow their students to use calculators when solving word problems.

What factors have impeded the acceptance of calculators as an important part of mathematics instruction? One factor may be the back-to-basics perspective of mathematics that is still held by many educators. Some schools, despite the recommendations for reform by NCTM, still maintain curricula that designate paper and pencil computational skills as prerequisite to the study of higher mathematics. An example of the emphasis still placed on paper and pencil computations is the placement test for algebra that was used in the school district that is the focal point of this study. A large proportion of the items on that placement test evaluated students' paper and pencil computational skills with fractions, decimals, and percentages. If paper and pencil calculation skills are viewed as a high priority in a mathematics curriculum, then calculators can be viewed as a way for students to circumvent mastering those skills. Schmidt and Callahan (1992) concluded that one factor impeding calculator use was fear that students would not master computational strategies and mathematics concepts on their own, but would use the calculator as a crutch.

As a result, students at the middle school and high school levels who have not mastered paper and pencil computational skills are caught in a ruinous cycle of taking "general mathematics" classes. Not recommended for advancement to potentially more motivating topics because of their lack of computational skills, these students are doomed to the boredom and frustration that accompanies the repeated practice of those skills semester after semester. For these students, calculators could serve a crucial role by providing them with a reliable method of computing. Freed of the computational "albatross", students could advance to the study of other mathematical concepts, in particular those of algebra. This paper describes calculator use in a summer pre-algebra program designed by a high school district as one part of their efforts to totally reform their mathematics curriculum. The assumptions that using calculators for computation is good and that students should focus on understanding were central to the program.

The Pre-algebra Academy

The high school district that is the focus of this study is located in a southwestern state and is comprised of two high schools. The district had the major goal of improving mathematics instruction at their schools by aligning their mathematics curriculum with the recommendations of NCTM. It was anticipated that through the process of alignment, they could develop a curriculum that would provide their students with motivating coursework that would prepare them for life by making them problem solvers. Major elements of the proposed reform included: the use of calculators in all mathematics courses (before these changes calculators were only used in trigonometry and calculus), a focus on conceptual understanding instead of procedural understanding, an increase of application and problem solving, and the placement of all ninth graders into algebra or higher course work. Historically less than 40% of the incoming freshman were placed in algebra or above.

In the initial stages of reform, the school district adopted a new mathematics series for the algebra, geometry, an advance algebra sequence that focused on concept formation, applications, and problem solving. Additionally it conducted a Pre-algebra Academy to provide ninth graders, who otherwise were to be placed in pre-algebra or general mathematics during the regular school year, with the opportunity to earn placement in algebra. The Pre-algebra Academy was a two stage project that included a two week summer teacher inservice program and a six-week summer student program. The goal of the academy was to upgrade the students' placement before the inception of the school year. The summer program was taught by 12 teachers who had participated in the two week teacher inservice program.

The summer program was based on the assumptions that all students can learn the concepts and skills necessary to successfully study algebra, and that the mastery of complicated computation was not prerequisite to attaining those concepts and skills. Outcomes for the student program included: the conceptual understanding of integers, fractions, and decimals; the conceptual understanding of the operations as applied to integers, fractions, and decimals; and the skill of applying those concepts in problem solving situations. To release the students from the paper and pencil computational requirements, the district purchased class sets of Casio f/g 7700 graphing calculators. After the summer program the calculators were placed in the regular high school mathematics classes to be available for student use throughout the year.

Data Collections

Teachers were surveyed before and after the two-week inservice component using Likert-type items written by the program administrators. The teachers indicated their agreement with statements by choosing "Strongly Agree", "Agree", "Disagree", or "Strongly Disagree". A portion of the items was related to their beliefs and practices concerning calculator use in their classrooms. Students were also surveyed before and after the six-week summer program using similar Likert-type items. Analyses of Variance were used to determine significant differences between pretest and posttest responses. In addition to the survey data, anecdotal data concerning calculator use were collected from teachers over the course of both the teacher inservice and student program.

Results From the Teacher Inservice

The pre-academy survey data indicated that the group of teachers chosen for the program had attitudes toward calculator use congruent with NCTM recommendations (see Table 1). With a score of "4" indicating strong agreement and a score of "1" indicating strong disagreement, the teachers disagreed that "calculators get in the way of learning" and that "calculators should only be used after paper and pencil computation is mastered" before the inservice. Their disagreement was stronger after the academy. Teachers indicated that they used calculators more by the end of the academy (they used them each day of the academy) and their confidence in using the graphing calculators increased significantly ($p < .01$).

The teachers were each issued one of the graphing calculators on the first day of the teacher inservice. The program planners encouraged the teachers to familiarize themselves with the calculators and use them as they experienced the inservice. The teachers' unlimited access to the calculators was also intended to mirror the student access to the calculators that would occur later. Although they all knew how to use a typical four function calculator, most of them (9 out of 12) were not familiar with the operation of the graphing calculators. The calculators' apparent complexity and unfamiliar use of symbols, for example, the absence of an "=" key, were a cause of anxiety to them The teachers were also concerned because they were supposed to help their students learn how to use these calculators and they did not know how themselves.

In addition to the daily access to the calculators, two hours of formal calculator training were provided on the third day of the teacher inservice. The training consisted of: (a) the teachers independently working through the "Quick Start" orientation section included in the calculator's handbook; (b) an exploration, guided by the chair of one of the high school mathematics departments; (c) of operations on fractions, decimals, percentages, and integers, and (d) examples of problems that were considered more difficult, for example, complex fractions. Although the training was minimal and the teachers were still not able to use the full capabilities of the calculator, by the end of the inservice, they were all confident that they could assist their students in using the calculators and deal with any difficulties that might arise. This change occurred even though only two hours of formal training were provided. It was concluded by the project coordinators that the daily use over the two week period probably was a contributing factor to the teachers' confidence in calculator use.

Results From the Student Program

The student program had an enrollment of 288 students who would begin high school that year. Of those 288, 262 were placed in algebra in their freshman year following participation in the program. Scores on the posttest from the summer program compared to the pre-test were an average of 59% higher. The large gain and other data sources not described in this paper were the basis for considering the summer program a success (Zambo, 1993b).

The teachers had gained confidence in their use of the calculators during the two-week inservice. However, they were still concerned that the students in the summer program would be intimidated, confused, and frustrated by the complexity of the graphing calculators, the feelings they themselves had experienced. The students were introduced to the calculators on the first days of the six-week program. The teachers as a group decided to have the students work through the "Quick Start" introduction provided in the calculator's handbook just as they had. They did not have high expectations, however. The summer program was designed as a remedial course, and the teachers believed that the low mathematics achievement of the students in the program would prevent them from understanding the calculators. Contrary to the teachers' expectations, the students were not confused by the sophisticated nature of the calculators, but excited. Teachers reported that the students, working in small groups, were able to work through the introduction with little need for assistance. Some of the students were so enthusiastic that they continued to work through scheduled break times.

During the remainder of the program the students were

Table 1
Statements, Pretest and Posttest Means, and Gains for the Teacher Questionnaire

Statement	Pre	Post	Gain
Calculators usually get in the way of learning mathematics.	1.45	1.20	-.25
Calculators should only be used after students learn how to compute with paper and pencil.	2.45	1.90	-.65
I use a calculator often.	3.00	3.50	.50
I can efficiently use a graphing calculator.	2.00	3.00	1.00 *

* Significant at the .01 level.
n = 11

allowed daily use of the calculators. Although the calculators were always available, there were frequent times when they were not needed. For example, using a manipulative kit to model integers was accomplished without need of a calculator. None of the teachers reported problems associated with calculator use. However, teachers did report positive aspects about the availability of calculators. Teachers commented that they had much more time to work on concepts and problem solving without the burden of practicing computational skills. They thought that the increased attention to concepts and problem solving was more interesting for the students than skills practice and that it required real "thinking" from the students. The teachers soon realized that the students were not "tied down" by their inability to compute. They reported that the use of the calculators eliminated the computational errors that frequently prevented students from correctly solving problems and felt that the students' confidence in their own abilities increased as a result.

With a score of "4" indicating strong agreement and a score of "1" indicating strong disagreement, the student pre-survey data indicated that the students in the program saw calculators as useful tools but did not use them much at home or in class (see Table 2). They also tended to agree that they liked to use calculators to solve problems and they would like to learn more about calculators. They tended to disagree that calculators made work more difficult.

After the academy, there were statistical differences on three of the statements. Students agreed more strongly that they used calculators in class (94% in agreement compared to 54% in agreement on the pre-survey). They also indicated a stronger agreement about liking to use calculators to solve problems. Moreover, disagreement increased to the statement that calculators make work more difficult.

The results of the student survey did not indicate any negative effects of calculator use. Other survey data, not reported here, indicated that the students' attitudes toward mathematics and their confidence in their mathematics ability increased over the course of the program. These changes cannot be attributed solely to the calculators, because several aspects of the summer program were different from courses the students had completed in the past. However, based on the teachers' comments about the students' attitudes toward calculator use, it seems reasonable to assume that the calculators contributed, in part, to the improved student attitudes and confidence.

Conclusions

The experience of the Pre-algebra Academy indicated that the inclusion of calculators can have a positive effect on the mathematics reform process. The student program was considered a vital part of the school district's reform efforts, and the calculators were a vital part of the student program. Teachers entered the program with reservations about the use of calculators, but gained both the skills and the confidence to allow calculator use in their classrooms with only a moderate amount of training. The introduction of calculators into the classrooms allowed teachers to "change the face" of mathematics instruction by focusing on concepts and applications instead of paper and pencil computational skills. Although preliminary data indicate that the program was a success, the most important evaluation will be the comparison of the progress of the project participants, as measured by semester grades, with non-participants placed in the same algebra classes. It is the belief of the school district that the use of calculators allowed teachers the time to build a foundation of conceptual understanding and thinking skills that will enable these students to continue successfully in the study of algebra. Without the use of calculators as a resource for computational requirements, these students would still be restricted in their mathematics advancement due to their lack of computational skills.

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Table 2
Statements, Pretest and Posttest Means, and Gains for the Student Questionnaire

Statement	Pre	Post	Gain
Calculators are useful tools.	3.59	3.79	.20
I use a calculator often at home.	2.44	2.31	-.13
I use a calculator often in class.	2.53	3.52	.99 *
I like to use calculators to solve problems.	3.14	3.52	.38 *
I would like to learn more about how to use calculators.	3.09	3.21	.12
Calculators make work more difficult for me.	1.76	1.44	-.32 *
Calculators are useful in math class.	3.47	3.72	.25

* Significant at the .01 level.
(n = 246)

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Teaching Mathematics with Calculators: Understanding Effects of Various Levels of Inservice

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The major influence of technology in mathematics education is its potential to shift the focus of instruction from an emphasis on manipulative skills and algorithms to an emphasis on development of concepts, relationships, structures, and problem-solving skills (Corbitt, 1985). Campbell and Fey (1988) have noted that use of technology must change not only how mathematics is taught (instructional component) but also what mathematics is taught (curriculum component) and the setting in which it is taught (contextual component). Technology could play a powerful role, both as a catalyst for change and as a resource to facilitate the transformation of teaching and learning (David, 1990). Together, reform and technology create a far more powerful force for change than either is alone.

The National Council of Teacher of Mathematics (NCTM) has repeatedly encouraged mathematics educators to reform the curriculum and incorporate more technology into classroom instruction. The *Curriculum Standards* (NCTM, 1989) emphasize problem solving, higher-level thinking, and communication and provide criteria for incorporating calculators into the school mathematics curriculum. The *Teaching Standards* (NCTM, 1991) advance the vision of high-quality instruction through the use of technology. Now, the *Assessment Standards* (NCTM, 1993) point to the need to make teaching and assessment consistent in their uses of technology. However, educators must determine effective methods for producing the suggested reforms and implementing changes in schools.

Teacher involvement in the planning and development of an innovation is a significant factor in implementation of that innovation. Stein and Wang (1988) examined curriculum development and implementation and found that innovations may produce disappointing outcomes, not because of inadequacies of the innovative idea but because of lack of teacher involvement in the development of the innovation. It is through the teaching process that classroom teachers breathe life into a new curriculum (Morin, 1986). In the final analysis, it is classroom teachers who implement a curriculum, adapt it to the needs of students, and inject into it their individual teaching styles. Quite simply, an innovative curriculum is not what the professional reformer has designed but rather what the teacher has made it.

Teaching Mathematics with Calculators (TMC) Project

The TMC project, directed by John Kenelly and John Harvey and funded in part by the National Science Foundation and the Texas Instruments, Inc., is designed to assist teachers in grades 6-12 learn to use calculators effectively in teaching mathematics. The project developed (a) a summer institute program (implemented in two school districts in Texas) and (b) video tapes and print materials which form the core of a "national workshop" for teachers to use at any school. The video tapes show classroom lessons, and the print materials provide model activities that can be used in instruction. Materials have been disseminated through the

Mathematical Association of America and the National Council of Supervisors of Mathematics. National evaluation surveys indicate that recipients of the materials are generally positive about them.

The model of teacher inservice for the two pilot districts is a teacher-leader model. One group of teachers was selected to participate in summer inservice sessions in two successive summers. During the first summer the goal was to help those teachers learn how to use calculator technology, both personally and in instruction. Teachers engaged in activities prepared by the project directors, and then teachers drafted materials that would illustrate for other teachers how to use calculators effectively in teaching mathematics. During the second summer, the teachers revised those materials from their perspective after one year's experience with calculators in instruction. The lead teachers then provided inservice for their peers.

Research on the Teacher Leader Model

The purpose of this study was to investigate the effects of both teacher involvement in the development of calculator materials and teacher leadership roles in the training of other teachers on instructional strategies and implementation of calculators in classrooms. Three groups of middle ($n = 8$) and high school ($n = 21$) teachers were compared: (a) lead teachers ($n = 11$) who received intensive calculator training from the project directors, assisted in the development of calculator materials, and served as teacher trainers, (b) teachers ($n = 11$) who received calculator training from the lead teachers, and (c) teachers ($n = 7$) who received no calculator training in the TMC project. The goal was to measure whether the three groups of teachers used calculators differently in instruction.

Three instruments were used during classroom observations: (a) Observation Rating Scale for Calculator Implementation, or ORSCI (Williams, Waxman, & Copley, 1991), (b) Observation Schedule of Teacher Roles with Calculators, or OSTRC (Williams, Mitchell, Waxman, & Copley, 1992 - a), and (c) Classroom Calculator Observation Schedule, or CCOS (Williams, Mitchell, Waxman, & Copley, 1992 - b). ORSCI, a high-inference instrument, assesses the quality of the calculator instruction, measures the amount of calculator use, and identifies the kinds of student activities involving calculators. OSTRC, a low-inference instrument, generates information on teachers and their behaviors when calculators are present; it measures interaction, setting, purpose of interaction, and nature of interaction. CCOS, a low-inference instrument, documents observed students behaviors in the context of ongoing classroom instructional-learning processes; it indicates which NCTM curriculum standards are being met, the types of classroom activities and student activities used, the setting, and specific uses of calculators.

Each teacher was observed by a trained observer during one complete mathematics period in February 1993; teachers were not told when the observation would occur. Eight 30-second sweeps of the teacher and an additional eight 30-second sweeps for each of six randomly selected students in the classroom were completed and scored on the OSTRC or CCOS instruments. Observation data were analyzed at the teacher level for possible differences among the three groups. The dependent variables reported here include three scales from ORSCI, four scales from OSTRC, and five scales from CCOS. For each indicator within these scales, mean scores for each teacher were computed, from which group mean scores were calculated and compared.

Results

Due to the small numbers of teachers in the three groups, statistical tests of differences were not significant. However, observed differences did show interesting trends that shed light on the inservice model of the TMC project. (In the discussion that follows, means in parentheses are always for groups a, b, and c, respectively. The maximum score in each case is 8.)

Whole group instruction was the predominant means of instruction, though lead teachers used small group instruction most often (1.55, 0.09, 0.00) and traveled from student to student or from group to group most often (2.09, 0.73, 0.86). Lead teachers placed the most emphasis on content (1.55, 1.27, 0.71) and the least emphasis on product (0.27, 0.55, 1.14); teachers in group b spent the most time on process (3.18, 3.36, 2.57). Lead teachers gave the most emphasis to questioning (3.09, 2.91, 2.43), listening (2.18, 1.73, 1.57), and modeling (3.82, 3.36, 3.14).

Students of lead teachers were encouraged most often to interact with other students about their class work (1.73, 1.05, 1.02) and were most often observed working in groups (1.88, 0.55, 0.45). Lead teachers demonstrated use of calculators most often (2.09, 1.91, 1.71), integrated calculator use throughout class activities most often (3.64, 3.09, 3.00), and provided the most opportunity for students to use calculators to explore mathematics (1.82, 1.64, 1.14). In contrast, students of lead teachers used calculators least often for computing (3.57, 3.85, 4.00), solving routine word problems (1.00, 1.38, 2.00), and checking answers (1.00, 1.13, 1.60).

Discussion

It appears that teacher involvement and teacher leadership roles in the development and implementation of an innovation (i.e., mathematics instruction with calculators) has some immediate effect on teacher instructional strategies and classroom activities. Research summarized by Loucks-Horsley and Hergert (1985) indicates that it takes from three to five years for a change to become totally incorporated into a teacher's instructional approach. Thus, we can expect that change among the lead teachers will continue and that differences between untrained teachers and teachers trained by the lead teachers might continue to increase. The data reported here support the lead teacher model as an effective way to promote change in large numbers of teachers. That is, lead teachers can be empowered to pass on their new perspectives to colleagues, and those colleagues can be expected to make changes in their instruction.

The results of this study also demonstrate that the level of change is affected by the degree of involvement in the change process. That is, more intense involvement is associated with more dramatic change. From one perspective this is not a surprising result; more intense interventions should be expected to produce greater changes. From a different perspective, it is important to understand that as the teacher leader model is implemented on a large scale, and as the deliverers of an innovation become more removed from the source of the innovation development, less change should be expected and more time may be required for teachers to make any pre-specified level of change. That is, lead teachers may need more time than experts like the directors of the TMC project to help their colleagues change. We will need to be patient in supporting lead teachers as they work with colleagues over an extended period of time.

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Lessons Learned from the Middle School Calculator Project About Teachers' Implementation of Technology

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This article summarizes three studies that were conducted in conjunction with a U. S. Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program Grant investigating calculator implementation, and calculator curriculum development, in middle school mathematics classrooms. The three-year project involved approximately 80 sixth, seventh, and eighth grade mathematics teachers, five middle schools, and 12,000 students from a large, multi-ethnic, metropolitan school district located in a large city in southeast Texas.

All of the middle school mathematics teachers in the district received at least 12 hours of inservice training on how to integrate the calculator into the curriculum. Some of these teachers were involved in the writing of calculator curriculum activities; others field tested the activities. The teachers were encouraged to incorporate into the existing curriculum the activities being developed as well as other activities that utilized the power of the calculator and implement an open policy on calculator use. Students were issued fraction calculators that they could take with them and use in all their classes as well as at home.

The three studies described in the present article were designed to identify differences in the implementation process among groups of teachers with varying initial attitudes toward calculators, among groups with varying responsibilities in the curriculum development process, between experienced and novice teachers, and between coached and non-coached teachers. Specifically, the three studies addressed the following issues: (a) the effects of teacher involvement in the development of calculator curriculum on the implementation process, (b) instructional differences involving calculators between experienced and novice teacher, and (c) the effects of coaching on technology use and instructional practices.

Effect of Teacher Involvement in the Implementation Process

The literature on educational change indicates that teacher involvement in the planning and development stages of an innovation is a significant factor in its implementation. Teachers must experience some sense of meaning, practicality, and ownership early in the change process for implementation to gain momentum; otherwise teachers will abandon the efforts and the implementation will fail (Cuban, 1990; Fullan & Stiegelbauer, 1991; Strathe & Hatcher, 1986). Because the teacher is the actual implementor of classroom change, successful classroom innovation is dependent upon teacher support and commitment (Crandall, 1983; Sarason, 1990). Commitment can evolve from participation in the development of curriculum because the participation offers teachers a role in shaping educational programs, a sense of involvement and responsibility in the implementation process, and thus a commitment to the success of the program (Morin, 1986).

The selection of the subjects for this quasi-experimental study was based upon the teachers' initial attitudes towards calculators and their involvement in curriculum development. It was hypothesized that teachers' attitudes toward change process. That is, more intense involvement is associated with more dramatic change. From one perspective this is not a surprising result; more intense interventions should be expected to produce greater changes. From a different perspective, it is important to understand that as the teacher leader model is implemented on a large scale, and as the deliverers of an innovation become more removed from the source of the innovation development, less change should be expected and more time may be required for teachers to make any pre-specified level of change. That is, lead teachers may need more time than experts like the directors of the TMC project to help their colleagues change. We will need to be patient in supporting lead teachers as they work with colleagues over an extended period of time.

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calculators and their involvement in curriculum development would affect the implementation process. This study compared the implementation process of three groups of mathematics teachers: (a) 15 teachers who had high attitudes toward calculators and were members of the calculator curriculum writing team , (b) 15 teachers who had high attitudes toward calculators and were not members of a writing team, and (c) 15 teachers who had low attitudes toward calculators and were not members of a writing team.

The curriculum writing team was released one day each month for two school years for the purpose of writing calculator curriculum. These meetings included more than curriculum writing and editing; they also included necessary discussions on issues involving curriculum change, calculator use, change of teacher's role when technology is present, and needed change in organizational structure of classrooms. The comparison groups of non-writers received the same 12 hours of calculator in-service training as the writers, participated in three district-wide calculator meetings with the writers, received input on calculator implementation during mathematics department meetings, and implemented what the writers wrote, but participated very little in the actual development of the curriculum.

During the spring semester of the first year of the project, each of the 45 teachers was observed four times by trained classroom observers. The Observation Rating Scale for Calculator Implementation (ORSCI) (Williams, Waxman, & Copley, 1991) was used to assess the quality of the calculator instruction, to measure the amount of calculator use in each classroom, and to identify the kinds of activities in which students are involved when they use calculators.

One-way analyses of variance were used to compare the three groups of teachers on each of the 17 observation indicators used to measure the quantity and quality of calculator instruction and use. In each case, the curriculum development group scored higher than either of the two control groups (Williams, 1993; Williams, Copley, Huang, & Waxman, 1993; Williams, Copley, Huang, & Bright, 1993). Significant differences among the three groups were found for seven of the indicators. Post hoc results indicated that the curriculum development group was observed significantly more often than the other two groups: (a) explaining relationships between calculator and paper-and-pencil algorithm, (b) stressing use of the calculator as a "time-saver", (c) stressing use of the calculator as a "problem-solving" tool, (d) initiating use of calculators in the classroom, (e) involving students in exploration and induction activities, (f) providing students with opportunities to solve application problems, and (g) allowing students to use calculators for self-checking and verification purposes once students have mentally computed or estimated answers. Surprisingly, no significant differences were found between the two control groups. These findings indicate that active teacher participation in curriculum reform involving technology may be a more significant factor than teacher attitude toward calculators for affecting classroom calculator implementation and selection of student activities.

From this study, we concluded that curriculum adaptation is, at least sometimes, an effective way to help teachers install an innovation. It also appears that the curriculum adaptation is more effective than short-term inservice training on the implementation process. The increased involvement in the curriculum design provided more opportunities, and created a greater need, for discussions on calculator implementation issues than the 12 hour inservice training, the district-wide calculator meetings, or the mathematics department meetings.

Implementation Practices of Experienced and Novice Teachers

Researchers have found that the planning and instructional behaviors of experienced and novice teachers are often different and that these differences can be identified and used to improve the novice teachers' instruction. Studies of effective teaching have identified several factors which differentiate expert teachers from novice teachers. These factors include: planning, adjustments to lesson during teaching, timing, pacing, focusing attention, guiding, questioning, managing, content knowledge, and pedagogical knowledge (Carter, 1988; Clark & Lampert, 1988; Clarridge, 1990; Feiman-Nemser & Buchmann, 1989; Leinhardt & Greeno, 1986; Livingston & Borko, 1989). Although there are numerous studies on teacher expertise, few have examined the instructional differences between veteran and novice teachers in technology-enriched classrooms. Recently, Jensen and Williams (1993) noted that in the presence of technology experienced teachers undergo managerial concerns not unlike novice teachers. They maintain that it takes at least one year before teachers can shift their efforts from managerial to curricular concerns. It is also possible that teachers (experienced as well as novice) need assistance in learning to effectively implement technology during instruction.

This study compared the instructional strategies, classroom interaction, classroom activities, and amount of classroom calculator use between 14 experienced teachers and 14 novice teachers. Each teacher was observed six times during the school year by trained classroom observers. The dependent variables were: (a) measures of teachers' use of instructional materials, (b) teacher's instructional activities, (c) classroom management, (d) set induction, (e) content focus above the skill/knowledge level, (f) teacher questioning, (g) emphasis on higher-level thinking in the classroom, (h) classroom environment, (i) teacher implementation of calculators, and (j) student activities involving calculators.

Mean percents, standard deviations, and t-values were computed for the comparisons between the novice and experienced teachers on the 10 scales (Williams & Mitchell, 1993; Mitchell, Williams, Waxman, Huang, 1993). The experienced teachers scored higher than the novices on each scale. Significant differences were found for four of the eight general classroom instruction scales: use of appropriate instructional materials, set induction, content focus above skill/knowledge and application level, and classroom environment. Two additional scales approached significance: questioning strategies ($p < .06$) and emphasis on higher order thinking ($p < .07$). Significant differences were not found, however, for either of the two scales which focused on calculator instruction and use.

The results of this study support previous research regarding the differences between the general instructional practices of experienced and novice teachers, and add to the research base regarding the lack of observable instructional differences when technology is present. It appears that the introduction of technology requires rethinking and retraining even for the teacher who is expert in instructional strategies.

Effect of Coaching on the Implementation Process

The importance of teachers observing other teachers and the development of peer and self-reflective strategies have been advocated since the mid-seventies and continue to be a focus of studies (Sharan & Hertz-Lazarowitz, 1982; Showers, 1984). Coaching, a process in which teachers can interact with other teachers to practice new and experimental techniques without fear of evaluation, is the method that is often implemented to accomplish effective change (Joyce & Showers, 1988). Coaching appears to contribute to transfer of training by encouraging greater long-term retention of knowledge and skill with strategies (Baker & Showers, 1984) along with a more appropriate use of newly learned strategies and models of teaching (Showers, 1982; 1984). Once again, few studies have extended these investigations to classrooms where technology is actively being used.

Fourteen teachers from the school district involved in the grant registered for a masters-level education class entitled, "Problem Solving with Calculators". The content of the course included: (a) instruction on the use of calculator technology, (b) instruction on effective teaching with technology, (c) instruction on problem solving heuristics and strategies, (d) modeling sessions by the two class instructors of the content emphasized during instruction, (e) two individual coaching sessions between university faculty and class participants, (f) at least two additional individual coaching sessions between class peers (peers as partners), and (g) an introduction to a variety of activities involving higher-level content and calculator use. The class instruction focused on how the calculator could best be used as a tool for higher-level thinking, problem solving, and student involvement. The importance of a student-centered classroom with its implications were stressed and modeled during the problem solving class as well as during the coaching sessions.

A modified version of Joyce and Showers (1988) coaching model was used during class instruction as well as during the individual coaching sessions. All coached teachers participated in the four individual coaching sessions. The sessions followed the following sequence: (a) university faculty taught participant's students, class participant coached, (b) class participant taught own students, university faculty coached, (c) one class participant taught, class participant partner coached (peer coaching), and (d) class participant partners described in part c reversed teaching and coaching roles. Each coaching session began with a presession in which the teacher and coach discussed the upcoming lesson objectives. During the coaching session, the lesson was taught by the teacher and the coach recorded observations, questioned students about their understanding of the lesson, and noted specific concerns. The coaching session then ended with a post discussion between the coach and the teacher in which the concerns were addressed, the observations and recommendations were reported, and future plans were made.

Fourteen additional teachers from the same school district were randomly selected to represent the non-coached group. Since the teachers taking the class were self-selected and impossible to randomly select, the non-coached and coached groups were compared using demographic data. Both groups were similar in educational background, number of years of teaching experience, ethnicity, gender, and participation in university course work beyond their degrees. The only observable differences between the experimental and control groups was in the level of their certification. Nine of the 14 coached teachers and four of the 14 non-coached teachers were elementary-certified rather than secondary-certified.

All teachers were observed by trained observers on four separate times during a 45-minute mathematics class period. Two of the observations occurred during early fall semester in which the coaching sessions and the problem-solving class took place; the other two in January after the class was completed. Teachers were not informed when they would be observed; coaching sessions were never observed by the trained observers. Four constructs were specifically observed in this study: (a) higher-level content focus in lesson, (b) use of calculators as problem-solving tools, (c) student-initiated use of calculator, and (d) teacher-initiated use of calculator.

Significant differences were found for three of the four constructs (Copley & Williams, 1993). The coached group spent significantly more time focusing on higher-level content than did the non-coached group during and after the coaching period. Significant differences during the coaching period were found between the two groups for use of "calculators as problem-solving tools" and "student-initiated use of calculators", but there were no significant differences between the groups on these constructs during the postcoaching observations. On Constructs 1, 2, and 3, the coached group had higher means, and the means increased from initial to post observations. No significant differences were found between the coached and non-coached groups on "teacher-initiated use of calculator" during or after the coaching period.

The results of this study support previous research regarding the effectiveness of coaching and add to the research base the observable effects of a short-term coaching model on the appropriate use of technology. The significantly greater higher-level content focus of the coached group of teachers that occurred during the coaching session and persisted even after the coaching session is a promising finding. The significantly higher use of calculator technology as a problem-solving tool by the coached teachers during the coaching session seems to be congruent with the higher-level content focus and further supports the effectiveness of coaching.

Conclusions

The findings from the Middle School Calculator Curriculum Project indicate that more effective calculator implementation occurred as a result of active teacher involvement in curriculum development, participation in peer coaching, and instruction in subject-matter (problem solving) content. Teacher attitude toward calculators, short-term inservice training, and general instructional expertise seem to have limited effects on the implementation process when technology is present. Training specific to effective teaching with technology appears to be necessary for both preservice and inservice teachers. More research on the implementation of curricular or instructional innovations involving technology, however, is needed for us to fully understand the contextual and implementation factors that influence teacher and student outcomes.

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The Relations Among Students' Calculator Confidence, Social Belonging, and Problem-Solving Achievement

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Middle school mathematics teachers are currently faced with many instructional dilemmas. Standards, for example, have been adopted from the National Council of Teachers of Mathematics that call for the integration of technology in the curriculum and an increased emphasis on students' problem-solving achievement in the classroom (National Council for Teachers of Mathematics, 1989, 1991). These changes in the mathematics curriculum, however, are often very stressful for classroom teachers because many have not had adequate preparation and training on how to effectively use technology and/or teach problem solving.

A second growing concern in middle schools today is the increased number of students who experience alienation in school (Calabrese, 1987; Gullotta, 1983; Tucker-Ladd, 1990). Secondary school students are often characterized as being (a) uninterested in their school work, (b) apathetic toward school, and (c) not having a sense of real accomplishment (Bishop, 1989; Boyer, 1983; Goodlad, 1983; Newmann, 1981, 1989; Sizer, 1984). To alleviate this student apathy and alienation, middle school teachers are encouraged to provide a warm, supportive environment for students in their classes in order to help students become affiliated with school and maintain a sense of belonging in the classroom. Again, this is often considered problematic for middle school mathematics teachers who have traditionally been trained as subject-matter specialists, rather than generic classroom teachers skilled in pedagogy, psychology, and child development.

Another important concern that teachers are currently asked to address involves students' confidence in using technology. While some students are inspired by technology, others are repelled by it. Showing students how to appropriately use the technology is not sufficient in order for them to become "users." Teachers also need to foster students' confidence in using technology as well as provide them the skills that address how and when they should use technology.

While there have been several studies focusing on teachers' implementation of technology (Hadley & Sheingold, 1993; Williams, Copley, Huang, & Bright, 1993), there have been very few studies that have actually looked at the consequences of technology use on students' affective outcomes. Furthermore, students affective outcomes, like confidence with calculators and sense of belonging, have not been specifically examined nor related to cognitive outcomes like students' problem-solving achievement. If mathematics teachers are asked to foster supportive classroom climates and develop students' confidence in using technology, it is important for them to know the extent to which these variables impact important student outcomes like problem-solving achievement.

The purpose of the present study was to investigate the effects of calculator confidence and student belonging on students' mathematics problem solving. In particular, this study looked at a multiethnic school district where all middle school students were issued calculators and all the mathematics teachers received training on how to integrate calculators into their teaching. Given the naturalistic setting of this study where calculator access was high and teacher training was provided, this study examined the affective components of calculator confidence and student belonging and related them to students' problem-solving achievement. More specifically, the study addresses the following questions: What are students' perceived confidence of calculator use and sense of belonging in the classroom, and how do these variables relate to students' problem-solving achievement.

Methods

This section includes a discussion on subjects, instruments, and procedures.

Subjects

The subjects in this study were 761 eighth grade middle school students who were randonly selected from a multiethnic suburban school district located in a major urban city in the South Central region of the United States. The ethnic diversity of the subjects was 31% white, 19% black, 22% Hispanic, and 25% Asian. The gender distribution was 54% female and 46% male. Most students in this district come from lower-middle to upper-middle class homes, and 40% of these students reported that they spoke a language other than English before they started school. Nearly 70% of these students reported that they are receiving mostly A's and B's in mathematics this year.

This district had received a three-year Department of Education grant to develop mathematics curricula which incorporates calculator usage. All the middle school mathematics teachers received at least 12 hours of training on how to effectly implement the calulator into their current mathematics instruction. Teachers also received calculator curriculum activities that had been developed specfically for the District during the previous year. Teachers were encouraged to utilize these activities along with others found to aid mathematics with calculators. In addition, an open policy for teaching with calculators among faculty members was encouraged in order to share information and new ideas. All middle school students in the district received a calculator that they could take with them to use in all their classes or at home. Near the end of the school year, about 46% of the students indicated that they used calculators in their mathematics classes everyday, while 28% responded that they used calculators 3 or 4 times a week, and 25% revealed that they used calculators only 1 or 2 times a month. Only about 15% of the students indicated that they use calculators in their other classes at least 1 or 2 times a week.

Instruments

The Student Perceived Calculator Confidence Scale and the Social Belonging Scale were derived from an adapted version of the SUPAI Student Calculator Survey (Bitter & Hatfield, 1992). The Confidence Scale consists of four items measuring student attitudes toward the use of calculators, while the Belonging Scale (also four items) measures student sense of belonging in their mathematics classrooms. Students responded to each item using a four-point Likert-type scale with "4" indicating strong student agreement with the item ("very true")and "1" indicating strong student disagreement with the item ("not at all true"). The instrument has been found to be reliable and valid in previous studies (Bitter & Hatfield, in press; Huang, 1993) and in the present study, the internal consistency reliability coefficient was found to be .68 for the Confidence Scale and .61 on the Sense of Belonging Scale. The median correlation of individual items and the overall scale was .50 for the Confidence and .65 for the Sense of Belonging Scale. The correlation between Confidence and Belonging was .10 indicating that the scales do not relate to each other and measure different constructs.

Student mathematics problem solving was measured in October (pre) and again in April (post) using the Four-Step Problem Solving Test (Hofmann, 1986). It is a multiple-choice, paper-and-pencil test designed to measure problem-solving skills of middle school students. The test consists of ten nonroutine problems each with four related questions. The test is based on a four-step heuristic: (a) read to understand the problem, (b) select a strategy, (c) solve, and (d) review and extend. The reliability of the total test for sample sizes larger than 19 ranged from 0.69 to 0.85 (Hofmann, 1986).

Procedures

The pre- and post Student Perceived Calculator Confidence Scale were given to all mathematics students in the fall (late October) and the spring (late April) semesters. To gain an understanding of student problem solving in mathematics, the Four-Step Problem Solving Test was also given to students at the same time. In addition, all teachers of mathematics at one of the five middle schools in the District were interviewed extensively. Multiple regression analyses were used to examine the effects of Calculator Confidence and Perceived Belonging on students' postmathematics achievement, after statistically controlling for preachievement.

Results

Table 1 reports the means and standard deviations for all the variables in the study. The range of possible values for each subtest of the Four-Step Problem-Solving Test is 0 to 10, while the range for the total test is 0 to 40. A mean value of four on the Confidence and Belonging scales indicates that students perceived that the particular variable was very prevalent (i.e., responded that all the items on the scale were "very true"), while a mean value of one indicates the students perceived that the particular variable was not prevalent (i.e., responded that all the items on the scale were "not at all true").

Generally, the descriptive results indicate that these students had average scores on all the Four-Step subtests. The overall mean on the total pretest score was only about 19, and it only increased slightly to about 20 on the total posttest. The overall mean values for most of the prettest subtest scores were about 5, while they varied from about 3.64 to 6.84 on the posttest. The standard deviations indicated that there was some variance on all the subtests as well as the total score. There were no subtests that had a large number of extreme scores. The mean value for the scale of Confidence was close to 3.0, which indicates that students responded that they were fairly confident about their work in mathematics. The mean value for Belonging was 3.17, which indicates that overall, students responded that they felt there was a sense of belonging in their mathematics classes. The standard deviation for the Confidence scale indicates that there was not a great deal of variance on the way students responded to that scale, while the standard deviation for Belonging reveals that there was more variation in the way students responded to that scale.

Table 2 reports the regression results for each of the five regression equations. A series of five setwise multiple regression equations were employed regressing each of the four subtest posttest scores from the Four-Step Problem Solving Test and the total Four-Step posttest score on the: (a) appropriate pretest score, (b) Confidence score, and (c) Belonging score. In the regression equation explaining student Understanding, for example, the Postunderstanding score was regressed on the Preunderstanding score, Confidence, and Belonging. The beta weights or standardized coefficients reported in Table 2 assess how a change in the dependent variable is associated with a unit standard deviation change in the values of the independent variables in the equation. The R^2 or coefficient of determination is also included in the table and it explains how much of the variance in students' postachievement measure is explained by the preachievement measure, Confidence, and Belonging. The Tolerance values for each of the independent variables in each of the regression equations were greater than .95 indicating that there were no multicollinearity in any of the regression equations.

In the regression equation explaining the Postunderstanding subtest score, the three independent variables accounted for 20% of the variance in the dependent variable. Preunderstanding had a moderate (*Beta* = .45), significant ($p < .001$), positive effect on Postunderstanding, while Belonging had a very slight (Beta = .04), positive effect on Postunderstanding. Confidence had a negligible (*Beta* = -.02) effect on Postunderstanding.

In the regression equation explaining the Poststrategy subtest score, the three independent variables accounted for only 15% of the variance in the dependent variable. Preunderstanding had a moderate (*Beta* = .38), significant ($p < .001$), positive effect on Poststrategy, while Belonging had a slight (*Beta* = .06), positive effect on Poststrategy that approached statistical significance ($p < .10$). Confidence had a negligible (*Beta* = .01) effect on Poststrategy.

In the regression equation explaining the Postsolution subtest score, the three independent variables accounted for 23% of the variance in the dependent variable. Presolution had a moderate (*Beta* = .48), significant ($p < .001$), positive effect on Postsolution, while Belonging had a slight (*Beta* = .05), positive effect on Postsolution. Confidence had a negligible (*Beta* = .02) effect on Postsolution.

In the regression equation explaining the Postextention subtest score, the three independent variables accounted for 22% of the variance in the dependent variable. Preextension had a moderate (*Beta* = .47), significant ($p < .001$), positive effect on Postunderstanding, while Belonging had a slight (*Beta* = .06), positive effect on Postextension that approached statistical significance ($p < .10$). Confidence had a very slight (*Beta* = .04), positive effect on Postextention.

In the regression equation explaining the Total Four-Step posttest score, the three independent variables accounted for 48% of the variance in the dependent variable. Pretotal had a large (*Beta* = .69), significant ($p < .001$), positive effect on Posttotal, while Belonging had a slight (*Beta* = .06), positive, significant ($p < .05$) effect on Posttotal. Confidence had a negligible (*Beta* = .03) effect on Posttotal.

Table 1
Means and Standard Deviations for All Variables

	M	SD
Postest—Four-Step Problem Solving		
Understanding	6.84	2.51
Strategy	3.87	1.76
Solution	3.64	2.09
Extension	5.72	2.11
Total	20.08	6.76
Pretest—Four-Step Problem Solving		
Understanding	5.11	2.16
Strategy	4.72	1.74
Solution	4.81	2.27
Extension	4.69	2.32
Total	19.34	6.93
Student Survey Scales		
Confidence	2.95	.46
Belonging	3.17	.62

Table 2
Regression of Postproblem Solving on Preproblem Solving, Confidence, and Belonging

	Dependent Variables				
	Understanding	Strategy	Solution	Extension	Total
Independent Variables	Beta	Beta	Beta	Beta	Beta
Preachievement	.45***	.38***	.48***	.47***	.69***
Confidence	-.02	.01	.02	.04	.03
Belonging	.04	.06@	.05	.06@	.06*

R^2= .20*** R^2=.15*** R^2=.23*** R^2=.22*** R^2=.48***

@ p<.10
* p<. 05
*** p<.001

Discussion

There are several interesting similarities and contrasts in the five regression equations. As expected, all pretest measures had positive, significant effects on the dependent variables. Second, Belonging had similar slight, positive effects on each of the dependent measures, while Confidence had negligible effects in most of the regression equations. In other words, the more belonging the student reported, the higher the posttest score. The degree of calculator confidence students reported did not appear to impact any of the dependent variables. This finding suggests that the emphasis teachers may place on students obtaining total knowledge of the usage of the tool may be unwarranted. A focus on actual problem solving strategies and heuristics may require a brief introduction to the calculator rather than an in-depth emphasis on mechanical usage.

Surprisingly, most of the total variance in the posttest subtest scores was not explained by the independent variables. Only about 20% of the variance was explained in the Understanding, Solution, and Extension subtests, while only 15% of the variance was explained in the Strategy subtest. About one-half of the variance was explained in the total Four-Step posttest. These results suggest that there are other, unexplained factors that account for most of the variance in the dependent variables.

One additional factor that may need to be addressed in future studies is the impact of instructional grouping practices on student outcomes. One teacher, for example, commented during the interviews how having students work in groups with calculators helps students develop a sense of belonging:

"From a real practical standpoint, when you're doing group work with four people and only 2 of them brought their calculators...the other 2 are not allowed to sit and not be effective. ...Okay, (I'll say) you don't have yours, then you need to do the recording here. They share calculators. They'll share papers. They'll share ideas. I think my group work enables the managerial aspect of only having, say 2 calculators in the group versus 4, to not be a problem, to just keep right on going because they do work together. They do share."

When another teacher was asked what were some typical things she heard kids say when they were working in these calculator activities, she stated:

"The best one of all is, 'I didn't get that. How did you get that?' That exchange is so positive with kids because you want them to say, 'I didn't get that. How did you get it? Let's go over it,' rather than, 'I like mine so I'm putting it down.' I mean, they're at least talking about it. Occasionally—you know how adolescent kids are—they'll say, 'Dummy, you pushed the wrong key. Do this, this, and this.' But they monitor and check each other a lot, and to me that's peer helping, that's peer coaching—and that can do nothing—in my mind—but enrich the involvement of the kid in that mathematical experience."

The need for learning technology is increasing in our rapidly advancing world. Too often the picture is portrayed in movies such as Jurassic Park of competent technologists who are loaners—"hackers" whose control of technology gives them a position of tremendous power yet are social outcasts. These negative images show schools as alienating, lonely places which produce students who are unable to work with others in business or in relationships . Teaching with technology, however, may actually work to reverse this prospect by providing students with a scaffold under which exist a network of cooperation (either teacher directed or "underground"). Both pre- and inservice mathematics teachers should be made aware of the inherently beneficial ways in which students seek to learn in social ways with technology. Active encouragement of such behaviors should be a part of new ways in which to teach technology. Further ethnographic research may provide a richer picture about the actual ways in which calculator usage may contribute to the feelings of social belonging in the classroom. Additional studies may also want to specifically investigate how teachers develop students' calculator confidence.

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Middle School Students' Calculator Confidence, Mathematics Anxiety, and Stages of Problem Solving Achievement

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In teacher education, the role and influence of technology on teacher and student outcomes has begun to be extensively researched (Waxman & Bright, 1993). One area that has not received a great deal of attention, however, is the relations among cognitive and affective student outcomes. For years there was a sharply delineated distinction between the cognitive and affective domains (Schoenfeld, 1992). Borrowing heavily from Mandler's (1975) thesis proposed in *Mind and Emotion*, Norman (1981) stressed the fundamental importance of the affective domain (where anxiety and attitude clearly reside) and identified affect as one of the 12 major issues that was being neglected in the development of information-processing models of purely cognitive systems (where mathematics achievement and problem solving reside). Although most research on the teaching and learning of mathematical problem solving has proceeded out of the Polya (1945) tradition which gives little attention to affective issues, McLeod (1989), Schoenfeld (1985, 1987) and Silver (1985, 1989) have made strong cases for the importance of affective factors in research on problem solving. McLeod (1989) claims that affective influences vary not only by problem solving strategy, but also by problem solving stages such as those identified by Polya (1945): (a) understand the problem, (b) plan solution, (c) carry out the plan, and (d) examine solution.

Bloom and Broder (1950) conducted one of the early studies of problem-solving processes. They found that students often encountered periods of tension and frustration, especially when they felt that their attempts to reach a solution were not productive. Although a little anxiety may help to keep us alert, over-anxiety can be self-defeating in that it can actually diminish the effectiveness of our efforts (Blackhouse, Haggarty, Pirie, & Stratton, 1992). A vicious cycle evolves when the anxious learner increases the effort to comprehend but understands less, and thus becomes more anxious (Skemp, 1987). Hembree (1990) concluded from a meta-analysis based on 151 studies that higher mathematics achievement consistently accompanied reduction in mathematics anxiety. The interrelationship between cognition and affect implies that mathematics teachers must consider the effects of affective components of learning mathematics when planning effective instruction (Adams, 1989).

Suydam (1987) found that calculator usage can have a positive effect on problem-solving achievement, feelings about self, and attitudes toward calculators. Jensen and Williams (1993) believe that much of the problem solving achievement gains may be the result of an effect they call "time compression." They claim that calculators can significantly reduce the time it takes some students to learn to solve problems. Calculators let students solve challenging problems that would otherwise take too much time with paper and pencil. Driscoll (1988) found that calculators provide several benefits to teachers. Calculators provide a powerful tool for evaluating the depth of students' mathematics understanding and facilitate the teaching and learning of several concepts and skills which have traditionally been stumbling blocks in secondary school mathematics. Research studies have not, however, investigated whether positive attitudes toward calculators and improved feelings about self are accompanied by increased problem solving achievement in middle grades. In particular, studies have not investigated the effects of students' perceived confidence in their knowledge of calculator use and level of mathematics anxiety on the various stages of problem solving. Information in these areas could impact teaching approaches used by mathematics teachers. This void in the research led to the development of the research questions for the present study.

The purpose of the study was to determine the relations between student perceived calculator confidence, student perceived mathematics anxiety, and stages (understand the problem, select a strategy, solve, check and extend) of students' pre and post problem-solving achievement. It was hypothesized that students' initial problem solving achievement would be highly related to their postachievement problem-solving scores, but of greater interest was the examination of the extent to which students' perceived calculator confidence and mathematics anxiety might also significantly relate to stages of their problem solving achievement at the end of the school year. In other words, the present study examined the extent to which calculator confidence and mathematics anxiety significantly ($p < .05$) affect students' post achievement in problem solving, after statistically controlling for students' initial or pre achievement test scores.

Methods

This section is composed of subjects, instruments, and procedures.

Subjects

The participants in the study were 1,540 middle school (i.e., Grades 6 & 7) students who were randomly selected from a multicultural school district located in a major metropolitan city in the South Central region of the United States. Of these students, approximately 45% were male and 55% were female, and 47% were in the 6th grade and 53% were 7th graders. The diverse population included 28% Asian, 22% Hispanic, 18% black, and 30% white students. Nearly 43% of these students indicated that they spoke a language other than English before they started school.

Approximately 36% of the students indicated that they used calculators everyday in their math class; 36% said they used it about 3 or 4 times a week, while 28% reported that they only used calculators 1 or 2 times a month. Nearly one-half of the students responded that they never used calculators in their other classes and about one-third of the students said they only used calculators 1 or 2 times a month in their other classes.

Instruments

The Student Perceived Calculator Confidence Scale was derived from an adapted version of the SUPAI Student Calculator Survey (Bitter & Hatfield, 1992). The scale consists of nine items measuring student attitudes toward the use of calculators. Students respond to each item using a four-point Likert-type scale with "4" indicating strong student agreement with the item ("very true") and "1" indicating strong student disagreement with the item ("not at all true"). Cronbach's Alpha which was used to determine the reliability of the Calculator Confidence Scale was found to be 0.68. The median correlation of the individual scale items and the overall scale was 0.55.

The Student Perceived Mathematics Anxiety Scale was derived from the Motivation Strategies Learning Questionnaire (Pintrich, 1990). The scale consists of five items measuring student anxiety in mathematics classrooms. A four-point Likert-type scale is also used for these items. Cronbach's Alpha of the Student Perceived Mathematics Anxiety Scale was found to be 0.71, and the median correlation of the individual scale items and the overall scale was 0.72. The correlation between calculator confidence and mathematics anxiety was -0.01 indicating that the two scales were not related to each other.

Student problem solving achievement was measured using the Four-Step Problem Solving Test (Hofmann, 1986). It is a multiple-choice, paper-and-pencil test designed to measure problem solving skills of middle school students. The test consists of ten non-routine problems each with four related questions which correspond to Polya's four stages of problem solving: (a) read to understand the problem, (b) select a strategy, (c) solve, and (d) review and extend. The reliability of the total test for sample sizes larger than 19 ranged from 0.69 to 0.85 (Hofmann, 1986).

Procedures

All middle school mathematics teachers in the district received at least 12 hours of inservice training on how to integrate the calculator into the curriculum. These teachers were also provided with calculator curriculum activities that had been developed the previous year. They were encouraged to incorporate these activities and others that utilized the power of the calculator and to implement an open policy on calculator use.

Students were issued calculators (as textbooks are issued) so that they could use them in all their classes and at home. In late October (approximately 10 weeks after students were issued calculators), the Four-Step Problem Solving Test was administered to all students during mathematics classes. Students were allowed to use calculators on the test. The Student Perceived Calculator Confidence Scale, the Student Perceived Mathematics Anxiety Scale, and the Four-Step Problem Solving Test were administered in late April; again calculator use was allowed for the problem-solving test. Multiple regression analyses were used to examine the effects of calculator confidence and mathematics anxiety on stages of students' post problem-solving achievement, after statistically controlling for Pre achievement.

Results

Table 1 reports the means and standard deviations for all the variables in the study. The range of possible values for each subtest of the Four-Step Problem-Solving Test is 0 to

10, while the range for the total test is 0 to 40. A mean value of four on the Confidence and Anxiety scales indicates that students perceived that the particular variable was very prevalent (i.e., responded that all the items on the scale were "very true"), while a mean value of one indicates the students perceived that the particular variable was not prevalent (i.e., responded that all the items on the scale were "not at all true").

Generally, the descriptive results indicate that these students had below-average scores on all the Four-Step subtests (problem solving stages). The overall mean on the total pretest score was about 16, and it only increased to about 19 on the total posttest. The overall mean values for most of the pretest subtest scores were about 4, while they varied from about 3.25 to 6.59 on the posttest. For both the pre- and posttest, *Understanding the Problem* had the highest mean value among all the subtest scores. The standard deviations indicate that there was some variance on all the subtests as well as the total score, and that there were no subtests that had a large number of extreme scores. The mean value for the scale of *Calculator Confidence* was close to 3.0, which indicates that students responded that they were fairly confident about their use of calculators. On the other hand, the mean value for *Mathematics Anxiety* was 2.2, which indicates that overall, students did not indicate that they were anxious about doing their mathematics work. The standard deviation for the *Calculator Confidence Scale* indicates that there was not a great deal of variance on the way students responded to that scale, while the standard deviation for *Mathematics Anxiety* reveals that there was a great deal of variation in the way students responded to that scale.

Table 2 reports the regression results for each of the five regression equations. In each regression equation, the dependent variable (i.e., either the total Four-Step posttest score or the individual subscale postscore) was regressed on: (a) its appropriate covariate or pretest score, (b) the Confidence score, and (c) the Anxiety score. In the regression equation explaining students' Understanding, for example, the Postunderstanding score was regressed on the Preunderstanding score, Confidence, and Anxiety. The beta weights or standardized coefficients reported in Table 2 assess how a change in the dependent variable is associated with a unit standard deviation change in the values of the independent variables in the equation. The R^2 or coefficient of determination is also included in the table, and it explains how much of the variance in students' Postachievement measure is explained by the Preachievement measure, Confidence, and Anxiety. The Tolerance values for each of the independent variables in each of the regression equations were greater than .95 indicating that there was no multicollinearity in any of the regression equations.

Table 1
Means and Standard Deviations for All Variables

	M	SD
Posttest — Four-Step Problem Solving		
Understanding	6.59	2.44
Strategy	3.66	1.57
Solution	3.25	1.94
Extension	5.21	2.10
Total	18.72	6.25
Pretest — Four-Step Problem Solving		
Understanding	4.26	2.01
Strategy	4.09	1.71
Solution	3.77	2.08
Extension	3.66	2.00
Total	15.78	6.23
Student Survey Scales		
Confidence	2.96	.48
Anxiety	2.23	.73

In the regression equation explaining the Postunderstanding subtest score, the three independent variables accounted for 20% of the variance in the dependent variable. Preunderstanding had a moderate (*Beta* = .40), significant ($p < .001$), positive effect on Postunderstanding, while Anxiety had a slight (Beta = -.13), negative, significant ($p < .001$) effect on Postunderstanding. Confidence had a negligible (*Beta* = .00) effect on Postunderstanding.

In the regression equation explaining the Poststrategy subtest score, the three independent variables accounted for only 10% of the variance in the dependent variable. Prestrategy had a moderate (*Beta* = .23), significant ($p < .001$), positive effect on Poststrategy, while Anxiety had a slight (*Beta* = -.17), negative, significant ($p < .001$) effect on Poststrategy. Confidence had a negligible (*Beta* = -.01) effect on Poststrategy.

In the regression equation explaining the Postsolution subtest score, the three independent variables accounted for 24% of the variance in the dependent variable. Presolution had a moderate (*Beta* = .46), significant ($p < .001$), positive effect on Postsolution, while Anxiety had a slight (*Beta* = -.07), negative, significant ($p < .01$) effect on Postsolution. Confidence had a slight (*Beta* = -.05), negative, significant ($p < .05$) effect on Post- solution.

In the regression equation explaining the Postextension subtest score, the three independent variables accounted for 18% of the variance in the dependent variable. Preextension had a moderate (*Beta* = .36), significant ($p < .001$), positive effect on Postextension, while Anxiety had a slight (*Beta* = -.15), negative, significant ($p < .001$) effect on Postextension. Confidence had a negligible (*Beta* = -.01) effect on Postextension.

In the regression equation explaining the Total Four-Step posttest score, the three independent variables accounted for 41% of the variance in the dependent variable. Pretotal had a large (*Beta* = .60), significant ($p < .001$), positive effect on Posttotal, while Anxiety had a slight (*Beta* = -.11), negative, significant ($p < .001$) effect on Posttotal. Confidence had a neglible (*Beta* = -.02) effect on Posttotal.

Table 2
Regression of Postproblem Solving on Preproblem Solving, Anxiety, and Confidence

	Dependent Variables				
Independent Variables	Understanding Beta	Strategy Beta	Solution Beta	Extension Beta	Total Beta
Preachievement	.40***	.23***	.46***	.36***	.60***
Confidence	.00	-.01	-.05*	-.01	-.02
Anxiety	-.13***	-.17***	-.07**	-.15***	-.11***
	R^2=.20***	R^2=.10***	R^2=.24***	R^2=.18***	R^2=.41***

* $p < .05$
** $p < .01$
*** $p < .001$

Discussion

There are several interesting similarities and contrasts in the five regression equations. As expected, all the pretest measures had positive, significant effects on the dependent variables. Second, Mathematics Anxiety had similar significant, negative effects on each of the dependent measures, while Calculator Confidence had negligible effects in most of the regression equations, with the exception of the Solution subtest. In other words, the more anxiety the student reported, the lower the posttest score. Students confidence in their use of calculators, however, seems to have no effect on problem solving achievement.

These findings seem to indicate that teachers may need to be more concerned with decreasing student anxiety during instruction and less concerned with the development of expert calculator users. Jensen and Williams (1993) report that when teachers are placed in technology-enriched classrooms, initially they have a tendency to focus more on the technology and the related managerial issues than on the learning environment and/or learning strategies. Typically it takes teachers at least a year to shift their efforts to curricular concerns. The low scores on both the pre- and postproblem solving achievement tests indicate that possibly the teachers of the students involved in this study may have been in the technology/managerial stage and were not focusing on problem solving strategies and heuristics.

It should be noted that the problems constructed for the Four-Step Problem Solving Test were not calculator-sensitive items. In other words, the use of a calculator to solve most of the non routine problems included on the test would not have been particularly beneficial. For this reason, one must be cautious when interpreting the results of this study.

Surprisingly, most of the total variance in the dependent variables was not explained by the independent variables. Only about 20% of the variance was explained in the Understanding, Solution, and Extension subtests, while only 10% of the variance was explained in the Strategy subtest. About 41% of the variance was explained in the total Four-Step test. These results suggest that there are other, unexplained factors that account for most of the variance in the dependent variables. Additional studies are needed to investigate other areas of the affective domain that might affect students' problem solving achievement in mathematics.

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SCIENCE & SOCIAL STUDIES

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The papers in this section focus on the integration of technology into science and social studies teacher education. In most areas of science the use of technology is not only accepted but expected. However, science teacher education, as most aspects of teacher education, has taken a back seat in the use of advanced technology. And when technology has been available its uses have tended to be traditional and replicative rather than revolutionary and exploratory. The growing availability of new technology for teacher education courses (perhaps because of lowered costs and newer, sturdier equipment) has coincided with the development of constructivist models of learning. With these developments science teacher education has multiple opportunities to become an exciting venue, a venue where *science* can truly be considered a verb as well as a noun — sciencing, not acquiring information about things scientific but processing for knowledge.

The first article by Woodrow describes a new course developed at the University of British Columbia that fills a void left at a pivotal point in the development of a technology-using science educator — the confluence of science content and instructional technology. Woodrow discusses the implications of such a course and its promise to foster "a new teaching and learning model." Her descriptions include the rationale behind the development of this new course, the software available for student exploration, some of the projects students developed, and quotes from a number of the students reflecting on their experiences with the course assignments. The opportunities for teacher education students to build their own constructs are evident from these firsthand reports.

In *Hands-On Technology-Based Assessment in Science* Peters and Land report on a continuing development project between faculties of the Wichita Falls Independent School District and Midwestern State University. Assessment, to some extent, drives the curriculum, despite an almost universal disapproval for the concept. When the assessment focuses on low level knowledge instead of process and knowledge building, the results all too often are low level rote learning. In addition, the authors note that "...evidence ... suggests that narrow focus on content associated with teaching science is also associated with technology and its use." The developers hope to break the cycles produced by these concepts by developing multimedia science kits and assessments that integrate a knowledge and process orientation to both science and technology. Initial results have been encouraging.

An ongoing concern in education is the inequality of technology diffusion across various school settings. Owens and Waxman address this concern in their paper, *Differences Among Urban, Suburban, and Rural High School on Technology Use in Science and Mathematics*. The results of their study have important implications for teacher educators.

In his paper *The Effectiveness of Audiovisual Teacher Guides in Courseware Packages*, Zehavi of the Weizmann Institute of Science - Israel describes an interesting facet of ongoing project. The project is one of development, evaluation, and implementation of software for teaching mathematics, but the teacher guides developed lead to critical thinking and problem solving in students as well as teachers. And the method of development serves as a good model for others interested in producing effective videos.

Exciting things can happen when universities and schools work in a collaborative fashion. This is evident in a report that bridges science and social studies teacher education. The paper, from Noretsky, Barrie, Hornick, Stifter, Whitley, and King, discusses the Social Studies and Science applications developed in their *Project Alive: Acquiring Literacy through Interactive Video Education.* (Other applications are discussed in other sections of this volume.) While Project Alive focuses on development of interactive instructional materials for teaching the deaf and hard of hearing, the approach has a great deal to say to a much broader audience. The excitement of the participants shines throughout this report.

Moving into the area of social studies are two papers dealing with geography education. Conditions today make geography a more compelling subject to study than it has been since the 18th and 19th Centuries. Those conditions are the shiftings — shifting of boundaries, of political alignments, of tribes of people—that have occurred and are occurring even as this is being written. This is happening at a time when the United States has fallen severely behind the rest of the literate world in knowledge of geography as well as the other social studies. Bringing our teachers and students up-to-date in a continually changing milieu is a formidable task. Fortunately, the same technology that hastens to bring us all closer together can also provide powerful means for expunging our ignorance.

The first paper, *Using Technology to Enhance Geography Education: The Educational Technology Leadership Institute* by Bednarz, reports on two intensive 16-day institutes, funded jointly by the National Geographic Society and IBM, held in the summers of '91 and '92. The goals of these institutes were not just to "teach the teachers," but to start a chain reaction of learning. By the end of the Fall semester, 1993, the ripple had reached over 19,000 educators. The specifics of the program make exciting reading.

In the final paper, *Computer Technology for Elementary School Teachers in Geography Education*, Ouyang gives a history of the current movement to reinstall geography into the elementary classroom. He provides an extensive overview of programs that may promote the success of that undertaking.

A Computer-Based, Multimedia Science Education Course

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Computer-based technology gives science teachers access to a wealth of textual and graphic information, new instructional strategies, and sophisticated laboratory and simulation tools. In 1993, the University of British Columbia (UBC) introduced a new elective course in the Science Education component of the Teacher Education program to introduce this technology to preservice science teachers and train them in its use. This paper describes the objectives and format of this course, reports student reactions to it, and indicates some of the outcomes that were achieved.

The introduction of the course, Computer-Based Science Education, was predicated upon the results of a survey of computer competency levels of secondary preservice teachers conducted at UBC in 1992 (Woodrow, 1993). These results indicated that a sizable percentage of preservice science teachers entered the program with advanced computer skills. Clearly, the standard introductory course covering the educational applications of computers was of little value to these students and few elected to take it. However, many preservice science teachers were graduating from the program with very little knowledge of, or strategies for, technology implementation into science education. The Computer-Based Science Education course was designed to be a practical, hands-on introduction to the integration of computer technology into secondary science instruction.

Course Rationale

Student enrollment in science and technology is decreasing at an alarming rate throughout North America. At the same time, the pressure exerted by an increasing scientific knowledge base has stretched school science curricula to its limit. The use of technology is an essential element of science teacher education because technology will play a key role in the current quest for new and more effective teaching strategies. The goals of these new strategies will be to encourage greater student enrollment in science and technology, and to develop the skills necessary to manage an ever expanding scientific data base. But, while computer technology *affords* the possibility of producing change and educational benefits, it cannot be *assumed* that either of these will automatically be realized merely because of technology's presence. Teachers must be trained in the application of technology-based instruction. Most educationally interesting uses of technology require adjustments in traditional teaching roles and instructional procedures — adjustments that even preservice teachers understandably resist due to a lack of training and effective models. Adjustments are also needed in student learning strategies and classroom procedures. Faculties of Education need to revise policies that provide appropriate technology training for teachers. Basic teacher computer literacy is clearly inadequate to prepare students to meet the technological expectations of the work environment. Teachers must be trained to teach *with* technology not just about it. UBC's Computer-Based Science Education course has been designed to train science teachers to implement *teaching* strategies that promote the best use of emerging technology in an environment where technology is an integral part of normal classroom procedures.

Course Curriculum and Format

In the Computer-Based Science Education course, students are introduced to a variety of computer applications and technologies, including microcomputer-based labs (MBL), simulations, interactive videodiscs, CD-ROMs, and multimedia tools. The course develops the skills, confidence, and strategies necessary for secondary science teachers to successfully incorporate these emerging technologies in their own classrooms both as instructional and learning resources. The major emphasis of this course is on understanding the application of various new, computer-based technologies, and the development of creative applications of technologies. Through a series of collaborative laboratory projects, students draw upon knowledge from earlier science courses to develop curriculum-based, computer interfaced experiments, lessons, activities and demonstrations in the areas of Biology, Chemistry, General Science, Geoscience, and Physics. The specific course objectives are that students be able to: (a) present a multimedia lesson, (b) prepare a simulation-based student or teacher activity, (c) prepare a computer interfaced student or teacher-demonstrated lab, and (d) prepare a lesson incorporating material from a videodisc. In addition, students prepare formal project reports and keep activity logs to help them reflect on the implementation of technology.

A driving force behind the development of this course was a personal conviction that the most appropriate application of technology in science education is the fostering of a new teaching and learning model. This new model is based upon learner mastery of information management and relationships, rather than on augmenting data delivery in conventional instruction, desirable as that goal might appear given the rate of growth of scientific knowledge. This model is predicted to include the following strategies:

1. active construction of knowledge by students rather than passive ingestion of facts;
2. use of sophisticated information-gathering tools that allow students to focus on hypothesis testing rather than gathering and recording data;
3. use of multiple knowledge representations, which allows for content management by individual learning styles;
4. collaborative peer interaction similar to team-based approaches used in modern work settings;
5. individualized instruction that targets intervention to each learner's current needs;
6. evaluation systems that measure achievement of complex, higher-order skills rather than recall of facts.

Each of these strategies was introduced into the course format to give preservice teachers first hand experience of the model. The course operates within an informal structure, where students work at their own pace, interacting frequently with the instructor, graduate student lab assistant, and colleagues, about the various activities. At the beginning of each lab project, students master the operation and use of technology by completing a collaborative tutorial activity. This mastery is then applied in the preparation of lesson activities — either teacher based or student based — that incorporate technology. Only two formal lectures are given — one to introduce the course and available technology, and one to illustrate successful implementations using videotaped examples of local teachers using technology in the classroom. Both lectures make extensive use of multimedia techniques and resources. Discussions, demonstrations and information exchanges are interjected on a "need to know" basis as students prepare to use a piece of hardware or software. The course format creates an environment that allows science education students to experience, perhaps for the first time, classroom situations in which the instructor functions as a facilitator of understanding rather than a transmitter of data. For many science education students at UBC, this course is their only opportunity to work in an open-ended laboratory format, "learning how to learn," not merely following a set of laboratory instructions.

The class meets for ninety minutes, twice a week, in the Mathematics and Science Education multimedia lab. This lab is equipped with twelve Macintosh computers (various models) networked to two departmental servers and one AST 486SX/66MH computer. Other equipment includes four videodisc players, four TV monitors, four CD-ROM players, Vernier and Champs II MBL interfaces and probes, an InFocus, active matrix projection panel, a laser printer, a camcorder, a scanner, a Radius digitizer, and a selection of science simulations, software and videodiscs. The lab is available from 1630 hours to 2000 hours, four days a week, for students to work on projects outside of class. Course enrollment is restricted to twenty due to equipment limitations, room constraints, and the highly interactive mode of instruction.

Sample Student Lab Projects

For most students, videodiscs prove to be the most unfamiliar technology encountered in the course. The lab projects produced are all the more impressive for this lack of familiarity. While students are given the option of accessing videodiscs via bar codes or computer, most choose the computer option. For example, two students, who produced the *HyperCard* project illustrated in Figure 1, started the course with no knowledge of either videodiscs or *HyperCard*. They used Voyager's *Videostack 2.2* to interact with the videodisc, *Visual Almanac*, and produce a set of buttons that access solar system images. Next, they created a *HyperCard* stack that organized the buttons, and contained a series of scanned images as well as user information and directions.

Two students, who completed the lab project illustrated in Figure 2, started the course with only an elementary knowledge of *Hypercard* and no familiarity with videodiscs. Using Voyager's *Videostack 2.2* to create the buttons, they built a six card stack that accesses an impressive series of images and motion sequences of the outer planets. The videodisc used for this project is *Earth Science - Astronomy*, Side 4 from Optical Data Corporation. This stack, and a similar one produced by another pair of students that incorporates images of the inner planets, were used in tutorial sessions in the fall of 1993 by the instructor of UBC's first year astronomy course.

The MBL lab project was the easiest for the preservice teachers to integrate into existing instructional strategies. Students quickly appreciated the opportunities for repeated data sampling and immediate displays of collected data, afforded by the use of probes and computer interfaces. Vernier's sonic ranger was identified as a particularly valuable tool, but the students also found creative ways to use pH, temperature, pressure, and oxygen probes. For example, one pair of students developed a grade nine lab activity that had pupils use pH probes to test various commercial antacid products. Another pair of students used the pressure sensor to develop a Chemistry lab on Boyle's law, replacing one in the curriculum that uses a mercury manometer. Two preservice physics teachers, who were placed in computer equipped classrooms for their practicum, used the force probe and sonic ranger to modify a standard dynamics lab on Newton's Laws. They then introduced the equipment to their sponsor teachers and used it in their practicum. Two students compared the merits of the Vernier and Champs II probes and software. They concluded that the Vernier material was more suitable to classroom use. It was easier to use and left most of the data analysis to students. The Champs II software was also judged to be non-intuitive — a real problem for experienced Macintosh users. In the future, only the Vernier interface and probes will be used in the course.

These simulation lab projects reflect the wide range available for student use. All available simulations are accompanied by tutorials, instruction manuals and sample activities. Students are encouraged to sample several simulations before choosing one to incorporate in a lab project. While tutorial type simulations like *MacFrog* are initially of interest, most students eventually conclude that the instructional possibilities of more powerful simulations, such as *Interactive Physics II*, *Voyager II*, and the Wings Exploration series, warrant their mastery. Some students choose to use their programming skills to create their own simulations. For example, two physics students used Interactive Physics II to create the activity illustrated in Figure 3. The simulation's purpose is to allow students to work out the parameters necessary for inserting the shuttle into a stable orbit. An activity and information sheet accompanies the simulation, encouraging physics students to use the "what-if" capabilities of the software. Another student used the ecology simulation of the Wings Exploration series to set up a student lab that explores Nigeria's ecology. The *Voyager II* simulation was used by a pair of Geology majors to develop an activity exploring the motion

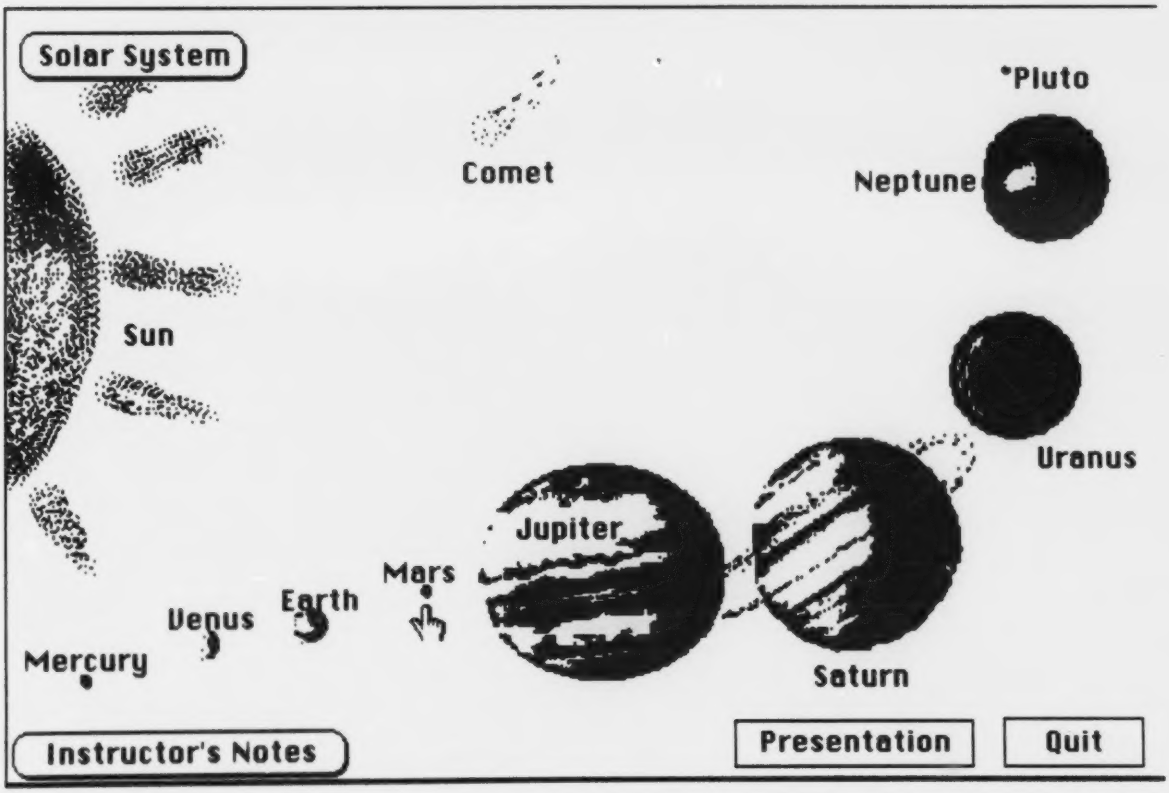


Figure 1. Solar System.

of comets in the solar system.

Student multimedia presentations generally consist of a project demonstration, the essential purpose of which is to give each preservice teacher an opportunity to develop and teach a technology-based lesson. Students are encouraged to integrate as much technology into a presentation as possible, including a projection panel, laser pointer, TV monitor and, of course, the computer. More experienced teams have supplemented their demonstrations with *Powerpoint* overviews. One student, who was familiar with the operation of videodiscs, opted to learn how to use the Radius digitizing board to capture images from a videodisc, incorporating them into a Powerpoint presentation that demonstrated the process. Arrangements were made for another student to produce a CD-ROM using the CD-ROM recorder and resources of a special, campus demonstration center equipped by Apple Computer (Canada), Inc. The CD-ROM formed the basis of this student's multimedia presentation and served to instruct the class in the production process. Arrangements are being made to test the use of this CD-ROM in UBC's first year astronomy course.

Student Reaction

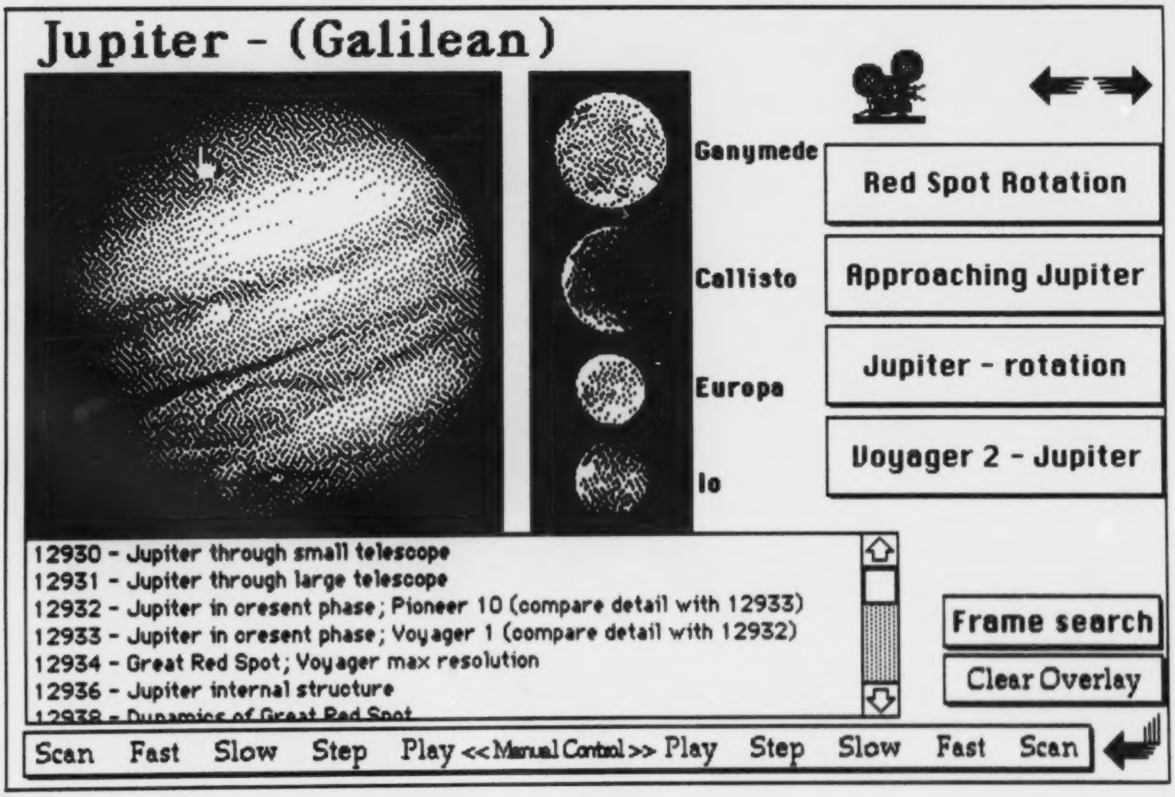
The course has now been offered twice — once in the summer and once in the fall of 1993. Although designed for secondary preservice teachers, the course has been elected by many graduate students as well as two elementary education students.

The following comments from student logs give a sample of reactions to the course, its content and format.

Its really too bad that this course isn't longer so that we could explore such things as CD-ROMs more thoroughly.

I started with anxiety and ended with an incredible feeling of applicability. I would recommend this course as a requirement for all education students.

I spent a lot of time on my projects mostly because I worked alone, hence I was not able to brainstorm my ideas with anyone. I actually think I enjoyed working alone because then I got into lots of trouble and I had to find my way out myself. I learned a lot trying different things by myself.



12930 - Jupiter through small telescope
12931 - Jupiter through large telescope
12932 - Jupiter in cresent phase; Pioneer 10 (compare detail with 12933)
12933 - Jupiter in cresent phase; Voyager 1 (compare detail with 12932)
12934 - Great Red Spot; Voyager max resolution
12936 - Jupiter internal structure
12938 - Dynamics of Great Red Spot

Figure 2. Jupiter Galilean.

I would say that this is a very useful, hands on course—probably the best one I have taken. And it should not be lumped in with the other courses by removing any aspect of the "hands on."

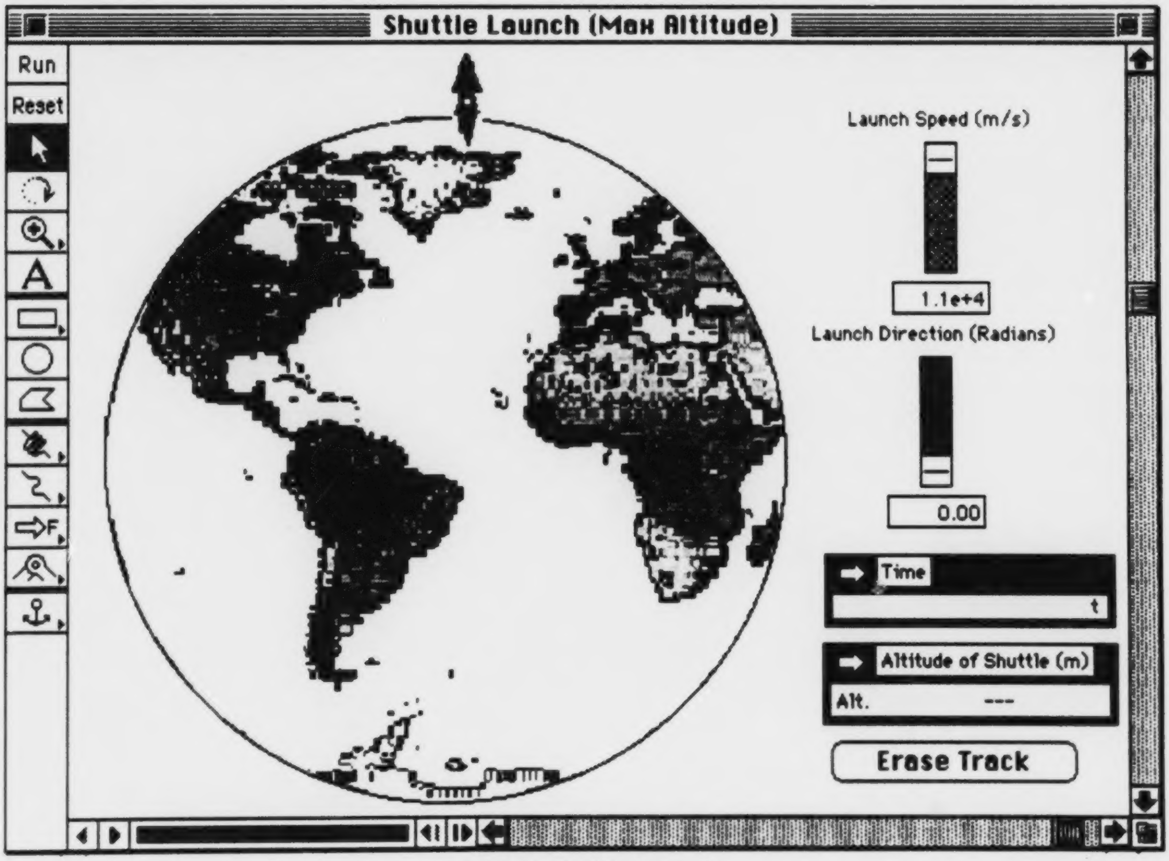
An unexpected student reaction to the course was a feeling of being overwhelmed by the opening lecture's introduction to technology. This first lecture was "toned down" somewhat when the course was offered a second time, and various examples and applications of technology introduced on a more gradual basis. While this approach lacked some of the "pizzazz" of the former, it was definitely more effective. The students all indicated that they valued the course's lab project format — it gave them an opportunity to learn by doing. The first project always takes students the most time to complete no matter which technology they choose first. After their first project, students are able to help each other and can master new technology more rapidly. Project presentations also help introduce new technologies. The presence of a graduate assistant is invaluable at the beginning of each lab project when students are exploring new technologies simultaneously and need guidance. Near the end of each lab project, however, there is always a noticeable decrease in student requests for assistance. It is at such times that the efficacy of the course's strategies — developing requisite technology implementation skills in the classroom — becomes irrefutable.

The fact that at least some course objectives were achieved is evident from the following student comments:

One of my course objectives has been met. I now can go into a classroom and not be afraid of using a computer and videodisc together to interface them with a concept.

By the end of this project, I'm comfortable that I would be able to teach with this technology, which was my goal for this course. Even though my projects were indicative of a beginner user of the Apple software, I am no longer scared of the technology.

Today I was just finishing up the write-up to the Boyle's law lab. The whole package seems quite nice and I foresee using this lab assignment in my classes. I don't have a set of computers in my class to allow all the students to use MBL but I do have a couple of computers



Launch Speed (m/s) 1.1e+4

Launch Direction (Radians) 0.00

Time t

Altitude of Shuttle (m)

Alt. ---

Figure 3. Shuttle Launch.

that I can use and a select group of students could do the lab using the MBL equipment while the rest of the class could do the lab by the traditional means. This would give me a chance to compare and contrast the results and maybe report them to my administrator. He could maybe see the benefits of MBL and spring a little cash to buy the equipment. (Graduate student)

If only I had MBL technology during my undergraduate work in Physics. This stuff is incredible. The sensitivity of this technology allows me to analyze real word events and get theoretical results which actually agree with the accepted theoretical results. What intrigued me the most was what happened when the resulting data didn't agree with what I expected. This caused me to wonder why this discrepancy occurred. Curiosity and intrigue resulted from my exposure to this technology, but I question whether this will occur with students. Do students in high school have a high enough cognitive development to appreciate MBL? I suppose the only way to find out is to try it.

Samples of student projects and a video showing the course in session will be used to further illustrate the outcomes and format of the course at STATE 94. The presentation will model, as closely as possible, the classroom instructional format.

Credits

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Hands-On Technology-Based Assessment in Science

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The Driving Force

"If tests are not designed with a clear understanding of what we want students to be able to do, testing can inadvertently reduce the quality of education" (Shavelson, Carey, & Webb, 1990, p. 25).

Those involved in the enterprise of public education often operate under the assumption of an ideal. That ideal, in brief, is that educational goals and objectives are the engines that drive the curricular and instructional wheels. In the real world tests often drive the curriculum and instruction. Teachers "teach to tests" and curriculum is artificially narrowed to include only that which may be found on tests. Educators from the classroom to the school board room constantly talk about test results and rarely about goals and objectives. Test scores sell real estate; goals and objectives do not.

In the 1980s two avenues to school reform began to merge. The "accountability movement" led many states to mandate assessment of students in specific subject areas. At the same time, science educators worked to develop operational definitions of "scientific literacy" (American Association for the Advancement of Science, 1989). Developers of state-level science assessments have tended to adopt broad definitions of "scientific literacy." Texas, for example, includes "acquiring and classifying scientific data..., communicating and interpreting scientific data..., solving problems by investigating..., and solving problems by applying knowledge" in its definition of the capabilities of a scientifically literate person (Texas Education Agency, 1993b, p.1-2).

Developers of state-level assessment instruments in many states, including Texas, indicate that driving instructional change is an important and intended outcome of their work. In regards to its assessment instrument, known as the Texas Assessment of Academic Skills (TAAS), the Texas Education Agency (TEA) states, "the science assessment will serve as a catalyst for...enhanced classroom instruction" (TEA, 1993b, p. ii). Further, TEA suggests that in preparing students to meet literacy goals, "instruction should focus on the entire body of essential elements rather than on a narrow body of skills and knowledge" (p. i).

The first TAAS-Science Assessment will measure student literacy in the spring of 1994. State guidelines call for the assessment to measure students' process-oriented science abilities and higher order thinking skills in part through multiple choice items and in part through hands-on, manipulative tasks. Regardless of its intent and nature, the state-level assessment ought not serve as a substitute for a sound program of local assessment. Wichita Falls ISD believes that ongoing, authentic, performance-based local assessment will have the greatest and most positive impact on curriculum and instruction, and thus, on student learning.

The Road Already Taken

Present science textbooks and methods of instruction, far from helping, often actually impede progress toward scientific literacy. They emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understandings in context, recitation over argument, reading in lieu of doing. They fail to encourage students to work together, to share ideas and information freely with each other, or to use modern instruments to extend their intellectual capabilities (American Association for the Advancement of Science, 1989, p.14).

Elementary science in Wichita Falls ISD (WFISD) is, at present, largely a text-based program of instruction. Science education literature suggests not only the shortcomings of science texts in general, but also the need for a strong foundation of scientific experiences for students at all elementary grades. During the 1990-91 school year, members of the WFISD Science Textbook Adoption Sub-Committee examined textbooks from a variety of publishers to determine their suitability for adoption. Upon examination, it became apparent to teachers, administrators, and curriculum specialists in the district that texts alone would not be sufficient to provide the kind of activity-oriented curriculum that research has shown to be most effective in stimulating students' interest in science and understanding of science concepts. Simply adopting new textbooks would not provide teachers with all of the tools needed to meet new demands from national scientific organizations and from the Texas Education Agency for the development of "scientific literacy" in our students.

As a first step in moving away from text-based instruction, the textbook adoption committee chose a laser videodisc program, *Windows On Science* (Optical Data, 1990), in place of one half of the state provided textbooks. Additionally, Wichita Falls ISD committed considerable resources to begin a program of development of hands-on science kits for grades Kindergarten through six. These kits are based on those from school districts around the nation that have implemented their own kit programs and from those kits commercially available from scientific organizations and supply companies. Kits purchased from these recognized leaders in elementary science education have undergone customizing to fit the unique needs and interests of students in the district. Kit activities are tied directly to ongoing local scientific investigations, local field trip sites (geological, biological, and technological), local resource people, and local community concerns. The kits include all the materials and supplies needed to involve the students in the active learning of science concepts and skills. WFISD teachers design science kits to include the best known educational practices. Cooperative learning strategies, inductive thinking, concept attainment strategies, videodisc technology, computer software and whole language strategies have been incorporated into kit activities as appropriate.

Kits and videodisc in combination are considered by many to be the "state of the art" in elementary science instruction. Even so, programs combining these two instructional approaches often lack assessment tools consistent with quality science instruction.

The Road Map to Literacy

The National Center for Improving Science Education (1990) identified goals for science assessment. Classroom level assessment should:

- be inseparable from and integrated into ongoing instruction
- serve science instruction at the local level while serving to inform policy at the state and national level
- reflect the desired understandings of science and technology and the desired proficiency with scientific and technological skills for elementary students.

Observational data from the elementary classroom, however, suggests that teachers' assessment practices currently do not match these goals. Assessment tends to be summative; it does not drive instruction; rather, it terminates instruction. Assessment tools are typically derived from text materials rather than from kit activities or videodisc materials. Further, most classroom assessment focuses on low level knowledge acquisition and fact recognition rather than on the multiple dimensions of scientific literacy as defined by the TEA.

Teachers, it has been said, tend to teach as they have been taught. So too, they assess as they have been assessed. Teachers in a newly formed WFISD assessment study group clearly see scientific literacy as being multifaceted; however, their collective body of assessment experience holds little in the way of assessing conceptual understanding, science process skills or habits of mind.

Wichita Falls ISD is seeking new ways to employ technology in the assessment of students' knowledge and abilities at the local classroom level within the context of the science activity kits. With Midwestern State University (MSU), WFISD teachers are experimenting with interactive media, including videodisc technology as a way to accomplish assessment goals. To these authors, videodisc graphics provide an enormous data base from which to assess concept and science skill acquisition and scientific habits of mind.

The Fox Rot

The Fox Rot (Land and Peters, 1993), is one of several technology based assessment tools designed to drive instruction toward the Texas "essential elements" for science (TEA, 1991a). Students are prompted to view five computer-generated, still photos of a fox carcass undergoing decomposition. They may compare these stills with a time-lapse "movie" of the decomposition process. Students then place the stills in sequential order and justify their sequence with observations and inferences made from the graphic data base. Scoring for the assessment activity is based on clearly defined criteria. (See Rubrics 1 and 2.)

Integrated Into Ongoing Instruction

Assessment tasks like *The Fox Rot* are meant to be formative measures of developing process skills. This task is currently being field tested within the context of a Grade 4 *Animals in Action* activity kit (WFISD, 1991). Essential Element targets in nine of the 14 kit activities correlate to Essential Element targets of the assessment. In all, six of eight Essential Element targets of the assessment are matched with instructional activities. Note: ideally all assessment targets should match instruction targets. As both the task and the kit are evolving, one to one match will be attained. Further, this task is likely to fit better in terms of content with *Worms and other Great, Small Creatures* (WFISD, 1992). This activity kit, which focuses on decomposition, has not yet been released to the schools.

Observations of early field tests indicate that fourth and fifth graders meet tasks like *The Fox Rot* with great enthusiasm, at least in a cooperative learning group setting. They readily and accurately sequence the graphic data (Essential Element 3A). Their dialog about the tasks is rich with observational and inferential statements (Essential Elements 2B, C, D, 4B, C and 6B). However, they write little of this down on paper (Essential Element 4F). This suggests that further instructional activities need to be designed to target the recording of student generated observation and inference.

Informing Policy at the State Level

The current TAAS assessment (Texas Assessment, 1993) relies on two dimensional, static, black line drawings to convey observable information to students (TEA, 1993a). The world, on the other hand, is filled with three dimensional, active, multi-hued information. WFISD and MSU assessment researchers are interested in exploring the effect that the medium of assessment might have on driving instruction. These authors believe that multimedia-based assessment tools will more authentically measure student ability to apply science skills in a real world context. The long term aim of this research is to provide models of technology-based assessment tasks suited both to the local classroom and state-level assessment requirements.

Reflecting the Desired Understandings

With the increasing presence of computers and other technologies in the public school classrooms, one might surmise that student encounters with these tools focus on gathering data and solving problems. Unfortunately, evidence from the field suggests that the narrow focus on content associated with teaching science is also associated with technology and its use. The computer, even in the elementary classroom, is often treated as an object to be studied rather than a tool to be used, the same mistake science teachers make by having students memorize the parts of the microscope. In part, this narrowed focus arises from teachers' misunderstanding the difference between computer science and the real-world use of the computer. It may be appropriate to study about the computer in a computer science class; it is an inappropriate use of time and resources to expect elementary students and teachers to approach the computer in this manner as a part of develop-

Rubric 1:
Observe/Infer/Communicate

Essential Element 2 (B, C, D) – Acquire data through senses
Essential Element 4 (B, D, F) – Communicate data and information.
Essential Element 6 (B) – Draw logical inferences

POINTS	CHARACTERISTICS
4	Observes/infers properties of the fox (which may include its surrounding environment) for all five photos. All observations and inferences are based on the graphic data set.
3	Observes/infers properties of the fox (which may include its surrounding environment) for four or three photos. All observations and inferences are based on the graphic data set.
2	Observes/infers properties of the fox (which may include its surrounding environment) for two photos. All observations and inferences are based on the graphic data set.
1	Observes/infers properties of the fox (which may include its surrounding environment) for one photo. All observaions and inferences are based on the graphic data set.
0	Makes no observations/inferences.

Rubric 2:
Sequences Data

Essential Element 3 (A) – Classify, order, and sequence data.

POINTS	CHARACTERISTICS
4	Sequences all 5 photos to match actual event
3	Sequences 3 of 5 photos to match actual event
2	Sequences 2 of 5 photos to match actual event.
1	Sequences 1 of 5 photos to match actual event.
0	Sequences none of 5 photos to match actual event.

ing general scientific literacy. Students and teachers need to know how to use technology tools (like the computer) in ways that individuals in the real world use them. We do not treat pencils as objects of instruction; neither should we treat the computer as such. They are both instructional and problem solving tools!

In elementary science classes, use of multimedia tools can aide students in performing scientific processes, such as the collection of data, the analysis of data, the representation of data, and communicating ideas. All of these tasks are real-world and can be accomplished without students knowing RAM from ROM or bit from byte! By changing the focus of assessment from low-level tasks and recall questions to performance of real-world tasks in a multimedia setting, the state and local school districts educators may also refocus the role of technology as a tool of instruction.

Conclusion

"The role and prominence of technology is growing. Not only is technology a tool for investigation, it is an instigator of whole new lines of inquiry" (Knapp et al., 1987).

Performance assessment using multimedia tools is a whole new line of inquiry for the Wichita Falls Independent School District and Midwestern State University. Early experiences suggest that multimedia assessment will facilitate teachers' integration of assessment with instruction, will guide assessment practices at the state and national level, and will focus the role of technology in the science classroom. Time and much more research will tell.

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Differences Among Urban, Suburban, and Rural High Schools on Technology Use in Science and Mathematics

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Mathematics and science education are two content areas where technology integration is being widely advocated by professional organizations, school-based educators, and teacher educators. Most preservice and inservice teachers acknowledge that instructional technology has the potential to significantly improve students' cognitive and affective outcomes (Padron, 1993). On the other hand, preservice and inservice teachers are often not aware of the potential dangers of technology. One potential danger is that overreliance on technology in mathematics and science will cause students to lose their computational skills. Another potential danger occurs when technology access and use are not equitably distributed across all types of schools. This a serious concern because equity and social justice issues are generally not addressed in either the teacher education literature nor in teacher education programs (Zeichner, 1992). More studies are needed to address these equity issues so that we can develop a research base that will enable use to make social responsibility a much higher priority in teacher education programs.

Several educators have recently raised concerns that the use of technology in the schools will actually widen the achievement gaps between high- and low-achieving students (Apple, 1988, 1991; Cummins & Sayers, 1990; Hativa, 1988; Johnson & Maddux, 1991; Sutton, 1991). Elementary and secondary students from higher-income families, for example, have been found to use computers in school and in their homes more frequently than students from lower-income families (Cole & Griffin, 1987; Jacobs, 1988; U.S. Department of Education, 1991). Minority students in urban schools have also been found to have less access to computers (Office of Technology Assessment, 1988; Picciano, 1991; Picciano & Kinsler, 1991; Piller, 1992). Most of these studies, however, have been relatively small scale studies comparing one urban district to a suburban district or studies that have examined technology use in general. Picciano (1991), for example, compared technology access and use between urban schools in New York City and suburban school from Westchester County. Although he found that the utilization of computer software was not dramatically difference across settings, he also found that the suburban schools had nearly twice as many computers as those from New York City. Large scale national studies in specific subject areas and grade levels are needed in order to determine the actual degree to which there are equity problems related to technology access and use in the United States. The purpose of the present study is to examine high school students' self-reported use of technology in science and mathematics. Moreover, this study compares technology use in high schools from three different community settings: (a) urban, (b) suburban, and (c) rural schools.

Methods

Data for this study were drawn from the first follow-up survey from the eighth grade cohort of-the National Educational Longitudinal Survey of 1988 (NELS:92). The NELS:88 survey design covered a two-stage, stratified

Table 1
Overall Summary of Technology Use in Science Classrooms

	Very Rarely	Once a Month	Once a Week	Almost Every Day	Every Day
Use of computers to write-up experiments or reports	88.2%	6.5	3.1	1.4	.8
Use of computers for collecting/analyzing data	91.2	4.4	2.4	1.2	.8
Use of computers for calculations	89.4	3.5	3.2	2.3	1.6
Use of computers for models and simulations	91.0	3.7	2.3	1.6	1.4

national probability sample. About 24,599 eighth graders, enrolled in 1,052 public and private schools across the nation, participated in the 1988 base-year survey, which examined the school-related experiences and accomplishments of eighth grade students, their parents, and their teachers, along with information on their schools. The first follow-up survey consisted of about 21,000 tenth grade students. Information about technology access and technology use in science and mathematics were also included in the student follow-up survey. For the present study, about 18,000 students are included in the sample. About 56% of the students were from suburban schools, while 29% were from urban schools, and 15% were from rural school settings.

Results

Table 1 reports the overall results for computer use in science classes. The findings indicate that about 90% of the tenth grade students reported that they "very rarely" used computers in science for (a) writing-up experiments or reports, (b) collecting/analyzing data, (c) calculations, and (d) models and simulations. Less than 4% of the students indicated that they used computers in science either "almost every day" or "every day."

Table 2 reports the overall results for technology use in mathematics classes. About 84% of the respondents reported that they "never" used computers in their mathematics classes and only 3% indicated that they used computers "often." Only 28% of the students, however, responded that they "never" used calculators in their mathematics classes. About 38% of the students said they used calculators "sometimes," and 34% indicated that they used calculators "often" in mathematics.

Table 2
Overall Summary of Technology Use in Mathematics Classrooms

	Never	Sometimes	Often
In your most recent math class, how often did you use computers	84.2%	12.6	3.2
In your most recent math class, how often did you use calculators	28.3	37.5	34.2

Table 3 reports the Chi square results by school setting and it reveals that there are two significant differences by setting for computer use in science. Students from urban schools reported using computers: (a) to write-up experiments and reports and (b) for models and simulations significantly more than students from suburban and rural schools. The Chi square results indicate that there are no significant differences on computer use in science for collecting/analyzing data and using computers for calculations.

Table 4 reports the Chi square results by school setting for mathematics and it reveals that there are significant differences by setting for both computer and calculator use. Students from urban schools reported using computers in mathematics significantly more than students from rural and suburban schools. On the other hand, students from rural schools reported using calculators significantly more than urban and suburban students.

Discussion

The results of the present study suggest that there are important differences on the use of technology in tenth grade science and mathematics classrooms by type of school setting or community. Students from rural schools reported that they were less likely to use computers than students from suburban and urban schools. Rural students also reported that they were more likely to use calculators than suburban and urban students. Surprisingly, students from urban schools were more likely to use computers in their science and mathematics classes. This may dispel the criticism that students in urban schools do not have as many opportunities to use computers as students from suburban schools. Also, the present findings indicated that high school students from urban schools are also more likely to use computers in areas such as developing models and simulations than students in suburban schools. This finding again contradicts some of the reports that criticize the ways students use computers in urban schools (Piller, 1992).

Another important finding from this study relates to the descriptive results that summarize students' overall use of calculators and computers. The results from the present study suggest that overall these tenth grade students do not usually use computers in their science and mathematics classes. This suggests that schools across the country need to do a much better job of integrating technology in the secondary school curriculum. It is also important to note, however, that these findings for technology use are some-

Table 3
Differences by School Setting on Technology Use in Science

Use of computers to write-up experiments or reports

	Very Rarely	Once a Month	Once a Week	Almost Every day	Every Day
Urban	86.6%	7.2	3.8	1.4	1.1
Suburban	88.0	6.6	3.2	1.5	.7
Rural	89.2	6.3	2.3	1.6	.6

Chi square (8) = 21.02, p = .007

Use of computers to collect/analyze data

	Very Rarely	Once a Month	Once a Week	Almost Every day	Every Day
Urban	90.3%	4.8	2.5	1.4	1.0
Suburban	91.2	4.3	2.5	1.3	.7
Rural	92.1	3.8	2.3	1.1	.7

Chi square (8) = 10.13, p = .256

Use of computers for calculations

	Very Rarely	Once a Month	Once a Week	Almost Every day	Every Day
Urban	90.3%	4.1	2.6	1.7	1.4
Suburban	91.3	3.9	2.2	1.5	1.2
Rural	91.5	3.3	1.7	1.7	1.8

Chi square (8) = 15.26, p = .054

Use of computers for models and simulations

	Very Rarely	Once a Month	Once a Week	Almost Every day	Every Day
Urban	87.0%	3.8	3.2	3.7	2.3
Suburban	89.4	3.6	3.2	2.4	1.4
Rural	91.2	3.4	2.5	1.9	1.0

Chi square (8) = 51.28, p = .000

Table 4
Differences by School Setting on Technology Use in Mathematics

In your most recent math class, how often have you used computers?

	Never	Sometimes	Often
Urban	83.5%	12.9	3.6
Suburban	84.9	12.4	2.7
Rural	84.4	12.2	3.4

Chi square (4) = 10.60, p = .031

In your most recent math class, how often have you used calculators?

	Never	Sometimes	Often
Urban	28.1%	35.9	36.0
Suburban	29.2	36.9	33.9
Rural	24.9	35.7	39.4

Chi square (4) = 30.99, p = .000

what lower than estimates previously obtained from teacher and/or administrator self-report data.

The issue of inequities among technology access and use is still a national concern (Picciano, 1991; Piller, 1992). Although it appears that the disparities among urban, suburban, and rural schools have been narrowed or eliminated in some areas, there are still several important issues that need to be addressed in this area. Further observational research is needed, for example, to verify the student self-reported results obtained in the present study. Other research questions that still need to be investigated include examining (a) the ideal or optimum levels of technology use that should exist in tenth grade science and mathematics classrooms, (b) whether there are other contextual variables like type of school (e.g., public or private) or state policies that influence the use of technology, (c) if family characteristics such as socioeconomic status influence the use of technology in schools, and (d) what other variables or factors differentiate high- and low use of technology. Future studies should also attempt to examine whether or not there are ethnic- and/or sex-related differences in the extent to which students report using technology. Finally, studies should begin to look at teacher education programs to investigate the extent to which preservice and inservice teachers are exposed to the potential dangers or misuses of technology in our society.

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The Effectiveness of Audiovisual Teacher Guides in Courseware Packages

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The Department of Science Teaching at the Weizmann Institute of Science is engaged in an ongoing project of development, evaluation and implementation of software for teaching mathematics. The software utilizes *transparency* which is a special feature that provides pedagogical meta-information of a student's work (Zehavi, 1993). This information is obtained by the software selectively following the student's work. The transparency is presented in a clear and organized manner and is ready for on-line use, while the student is working. The software transparency, by its own nature, yields significant scenarios for motivating teachers to play an active role in using the software in their classes. Therefore, the implementation aspect of the project involves the creation of audiovisual teacher guides that combine critical issues in the development of the transparent courseware and demonstrations of successful teaching strategies. The accent in the films is in teaching the instructors to intervene appropriately and constructively where necessary. The development of such videocassettes is based on research and professional training courses for teachers which are held in an inschool framework. The production approach which implements script-templates will be described using a particular software package in algebra. The experience gained in using the videos in professional training courses for teachers leads to further development of technology-based teacher guides.

An Audiovisual Teacher Guide for *Dots and Rules*

The object of the software *Dots and Rules* is to establish connections between linear equations, given in verbal form (e.g., "the sum of the coordinates is -2") and their graphs. The tasks are imbedded in a series of tutorials and a competitive game for two. The software has points of contact with the junior high school curriculum at various points, but it can be considered as a "process game" rather than a "content game" (Olds, Schwartz, and Willie, 1980). This basic feature of the software has relatively clear implications for the design of instructional materials for teacher education: The focus should be on the learning processes of cognitive skills that occur during student-computer interaction.

The Software

Whereas most junior high school students successfully read and plot points, they have difficulties in understanding the relations between the two coordinates of points. The software *Dots and Rules* offers various tutorial activities which teach the two-way association: point <-> rule, where the rules are given in non-formal form (without algebraic expressions). The student has to identify which points (dots) fit a given rule or which rule fits a given point. After the student determines the correct rule/dot, the dot is given a special shape and color specific to the rule, and the picture of the straight line on which these dots lie, should be clear. The game is based on the well known strategy "four in a row". The players aim to occupy four points on a line, and the line is described by a rule. The player has to associate a "strategic" point with one of the rules that appear on the screen at that stage.

In previous studies related to an early version of the software (Zehavi, 1988), different modes of learning were observed. The research findings led to the design of the student interface in the new version, and to the construction of the follow-up component and the coaching component. A dot can be indicated either arithmetically by entering its coordinates, or graphically by using the arrows to fix its location. The student's mode of work is assessed first by his/her preferred method for indicating dots on the coordinate system while working with the software. The computer also checks other aspects of the student's work. For example, it checks whether the student identifies the rule satisfied by subsequent dots more quickly than for previous dots, in which case the computer "believes" that the student has seen the straight line and is making graphical considerations in completing the task. Support and feedback are given to the student according to the system's belief about the student's state.

The Script

One possible approach to the development of instructional materials in teacher education is creation of a database that combines research-based teaching strategies with videodisc demonstrations of the strategies (Abate, 1993). We also started the production process by taping portions of authentic classroom lessons and teacher workshops, and then using the successful segments in films to be used by tutors. From informal evaluation it became apparent that teachers expect high quality photography and a stand-alone (i.e., tutor-free) product. Some attempts to write precise scripts, and to direct students and teachers to perform, turned out to be "too directed" to be true. However, the accumulated experience led to an alternative approach for which we prepared script-templates that allow a trade-off between authenticity and directed performance. As explained above the software caters to individual student needs; thus one cannot plan in advance the detailed flow of learning and instruction. While watching the class the experienced team decides what episodes to videotape. The chosen players are then directed to repeat their own actions in front of the cameras. The editing process involves the writing of fitting narration for the film. In the following we describe the actual script of the film that accompanies the software Dots and Rules.

The films begin by explaining the goals and strategies of the software via episodes of students performing mathematical considerations while working on the various activities. The goal of the first activity is to establish the transfer skill dot -> rule. The dot (-4,-8) is flashing and OM has difficulties in identifying the appropriate rule "Y is two times X" (which is denoted by a yellow spade) because of the negative sign of the coordinates. After eliminating the other easier rules he watches the screen and sees two other dots, already marked by yellow spades, in the first quadrant where the coordinates are positive. He waves his hand instinctively from the marked dots toward the flashing dot and confirms loudly and very carefully that the rule is satisfied by the coordinates. Gradually the student is learning to use the graphical representation to associate the dots to the rules and he is able to mark quickly the flashing dots.

In the next activity the task is reversed - the rule flashes on and off, and the student is asked to identify the dots whose coordinates satisfy the rule and to mark each of them by either: ***coordinates*** or ***arrows.*** The evaluation done by the software considers both the student's level of performance and mode of work. The level of performance is graded from 1 (high) to 3 (low); the mode of work is assessed as (A)rithmetic, (G)raphic or (M)ixed. This information is displayed on the screen and is thus "transparent" to the teacher. MT, a girl in the film, is combining arithmetical and graphical considerations in her work and one can see that the computer's estimation of her level of performance is average and that her working mode is believed to be mixed. As she progresses she is beginning to relate to more than one point at a time and thus she identifies a "convoy" of dots which satisfy a rule.

After this introduction the movie turns to a classroom session, and we see how the class teacher presents, in brief, the software and the two options for fixing the location of a dot. The students start to work independently and the management of the class is taken by the tutor from the Weizmann Institute. She is performing the role of the teacher who has been asked to observe one student and to fill an "observation table". The computer also generates a follow-up record which can provide more detailed information on the computer's evaluation of the student's work, how the computer reached its decision, and different types of treatment initiated by the computer. After the session the teacher will compare her filled-out form with the "stored transparency". The on-screen visible transparency invites the intervention of the tutor. She notices that DK tends to work graphically at a low level of performance, and initiates an intervention. She wants to improve his performance and instructs him in arithmetical arguments, because of his graphical mode of work. At the same time the computer provides "appropriate" feedback to the students: arithmetical feedback is given when it "senses" that the student makes mistakes because of the tendency to work graphically, and for a student who needs support and tends to work only arithmetically, the computer causes dots which fit the rule to flash occasionally, hopefully drawing the student's attention to the linearity.

The students work individually on the tutorial part of the software; the computer provides treatment which also includes repetitions of several activities and changes of the levels of the rules that appear; and the tutor intervenes where necessary. Students who complete the tutorial move on to the game for two. OM and MT are now playing the game. MT wants to occupy a strategic dot which will complete three "fours" but cannot associate it to any of the given rules; she then decides to check what unoccupied dots she can fit to the rules.

This two-way association of dots and rules invites high-order mathematical considerations: at a certain moment MT stops substituting the coordinates in the rules and becomes interested in the ***relation*** between the two coordinates of a strategic point. She calculates the sum of the coordinates, reviews the current list of rules and is happy to find a rule of the category "sum of coordinates is constant" that fits.

Toward the end of the session the class teacher utilizes a worksheet that accompanies the software in a class discussion. The discussion focuses on the key problems presented by the software. One can see how the different modes of student work filter into the discussion.

The students leave the computer lab and the teacher reports to the tutor on the one-student observation she made during the session. She describes, with apparent enthusiasm, that the girl she observed started her work in an arithmetical mode. Then she noticed that "the dots appear in a convoy" and gradually switched to a mixed mode of work. This is the time for the tutor to expose the stored transparency of the computer (which is accessed by a key press). The computer record "validates" the story of the teacher who seems to be very contented.

The video then presents a segment, taped at a teacher course, where teachers browse enthusiastically through the stored reports and compare them with their own findings. A collage that links together the four components - subject matter, software, student and teacher - concludes the film.

Effects on Attitudes and Implementation

The attitudes of teachers who were guided in the implementation of transparent software by the videocassettes are encouraging. The comparison of the behavior of teachers before and after watching the videos is striking. The most important factor is that after watching the videocassettes the teachers come to rely less on the project team and more on themselves. In the follow-up reports from the teachers we could analyze the key factors identified by Hadley and Sheingold (1993) as contributing to teachers' accomplishment: motivation and commitment; support and collegiality; access to technology. It was clear that, in general, motivation and commitment increased. Regarding the two other factors we can be more specific about the effect of the videos.

Familiarization with the software

Each software package includes a comprehensive written Teacher Guide which contains a description of activities, example worksheets and discussion sheets, and gives an explanation of the transparency features. Our impression has been that teachers do not make full use of the Guide, they prefer demonstration and explanation given by a tutor. The videos which take 17-25 minutes to play seem to provide a better support. Even teachers who have had extensive experience in implementing a particular software (and sometimes also a new tutor) admitted that the film revealed details that they were unaware of. For example, in the case of *Dots and Rules* they were unaware of the fact that the computer measures student reaction time for subsequent points on a line. During the preview sessions we ourselves came to realize and to appreciate the amount of information that can be communicated via this medium.

Presenting the software in the classroom

While evaluating teachers' experience in practice we observed very often that teachers had difficulties in presenting the software in the class in a concise but clear way. They frequently digressed to an explanation of the subject matter of the courseware and solved exercises for the class. We mentioned above that the film first demonstrates student learning processes, before the actual "beginning of the session". Our intention was to convey to the teachers that students could solve problems individually by interacting with the software, rather than being directed toward a specific mode of solution. In any event, some of the teachers noticed that in the film the teacher makes a very brief presentation with an emphasis on the two options for fixing the location of a dot (entering the coordinates or using the arrows). Other teachers expressed their anxiety that students would not observe the linearity unless it is pre-explained to them. We suggested that teachers try and see what happens in the class. Most of the teachers admitted later that they just could not refrain from providing some hints. However, in almost every school there was at least one teacher who presented the software as seen in the film (some used the segment of the video in the class - not being sure of themselves). These "brave" teachers came to the next staff meeting with lively anecdotes of how students came to grips with the goals of the software. An on-site bootstrapping process has begun.

Visible transparency and teacher intervention

Before the professional training courses were held in the schools, the teachers filled out questionnaires asking about their view of the role of the teacher in a computer-assisted lesson. The following emerged: the majority of the teachers felt that they had no defined role beyond presentation and explanation of the technical aspects and the goals of the software; some argued that they could not possibly monitor the progress of all the students. In the training courses, expert tutors exhibited (live or in films) how the codes of the visible transparency enable them to ascertain at a glance the progress of the students in the class and perform appropriate intervention. This transparent feature of the software was very successful in motivating teachers to play an active role. After watching the tutor's performance, usually teachers got involved in firm pedagogical discussions about the actions taken by the tutor. Later on they practiced active implementation, and reported to colleagues, in detail, about their experience in monitoring class work. Some invited other teachers to observe and aid in their classes. Again, on-site support and collegiality emerged.

Implementing the stored transparency

Our early experience with the stored transparency indicated that there was a tendency to regard it as an automatic grading system for student evaluation. To correct the wrong impression we demonstrated in the films how to act on the given information, as it becomes available, to support students. We put a lot of media effort into preparing these scenes. For example, while the tutor and the teacher compare the observation table to the computer report, we see in flashback the student's behavior and concurrently some relevant elements of the software. We also note that the notion of the stored transparency varies tremendously from courseware to courseware, focusing on the subtler points where students tend to make mistakes. The teachers we worked with had difficulties in comprehending all the information unless they had had intensive training on the specific package. They found it difficult to integrate the software and the film in relation to the stored transparency, and expressed their wish to be able to navigate easily between the two technologies.

In conclusion, this practical work and its evaluation led us to recognize the need to link the audiovisual teacher guide to the courseware itself using multimedia techniques. It might be desirable to include in a courseware package the pedagogical experience accumulated while developing the courseware and while training teachers to implement it. In such a way the educational technology may become a successful instructional tool for its own implementation.

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Interactive Video, Hypermedia, and Deaf Students: Social Studies/ Science Applications

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Frost Intermediate School

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Athens Drive High School

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Gallaudet University

Project ALIVE!: Acquiring Literacy through Interactive Video Education is a federally-funded project designed to assess the implementation and the impact of interactive video on the reading and writing of deaf high school and intermediate-level students. The project provides training, support, multimedia equipment, and resources to teams of two faculty from each of four programs for deaf and hard-of-hearing students.

The basic goal of the project is to provide teachers and students with tools for enriching instruction through visual means. The project's toolbox includes (a) multimedia programs (Asymetrix's *Compel* and *Toolbook*), (b) electronic resources (e.g., Microsoft's *Bookshelf* and *Software Toolworks Multimedia Encyclopedia*), (c) basic productivity tools (e.g., Window's Accessories and other programs such as Microsoft *Word*), (d) clip art and scanned images libraries, and (e) captioned videodiscs.

In this paper, only one example from each participant is provided—showing you the richness and creativity of all of their work is beyond the scope of this report. Suffice it to say that the group happily shared their instructional strategies and ideas and that the examples presented herein are simply representative of the strategies the group as a whole developed. The examples are organized as follows: (a) visually-supported instructional strategies, (b) uses of graphic organizers, (c) uses of hypermedia resources, and (d) student uses of hypermedia and interactive video.

(Note: This paper addresses applications in content areas such as science and social studies. King et al., in this volume, address literacy applications. King and Larkins, in this volume, address issues related to the process of implementing interactive technology in classrooms for deaf and hard-of-hearing students.)

Visually-Supported Instructional Strategies

Each of the teachers in the project selected a captioned movie on videodisc to use as the basis for their first effort with interactive instruction. The content area teachers and the media specialist repurposed the videodiscs, rather than using them to teach the story lines of the movies or other literacy skills.

Science Applications

Wilda Whitley used the movie *Innerspace* as the basis for her instructional unit. Video clips from the movie were linked to an outline of body systems in *Compel* and to the program *Body Works*. Innovative instructional strategies included a progression of screens (ending with the graphic organizer shown in Figure 1) to help students link their previous background to the new vocabulary introduced in *Innerspace*. New concepts (such as miniaturization) were also presented via animation.

Social Studies Applications

Jim Barrie used the movie *Dr. Zhivago* as the basis for his instructional unit on the Russian Revolution. Hyperlinks were created between various video clips and an outline generated in *Compel*, which also included a variety of textual screens, charts, and pictures. Figure 2 presents one of the graphic organizers he used as the basis for discussions of pre-revolutionary uprisings. Clicking on a node of the web would take the reader to more information on the topic. Clicking on a video button would take the reader to a video example.

Rosemary Stifter used the movie *Glory* as the basis for her instructional unit. An example of an instructional screen to help students develop better comparison and contrasting skills is shown in Figure 3. In this activity, video clips—along with text or graphics when video wasn't available—served as the basis upon which the lives of different groups of soldiers could be compared.

Sign Language Applications

Tony Hornick, the media specialist in the group, worked extensively with the movie *School Ties*, but his plans for future development rest more in the area of digital video. Using a video test template from the Institute of Academic Technology, he developed a prototype sign language video test that could be used with both deaf and hearing students

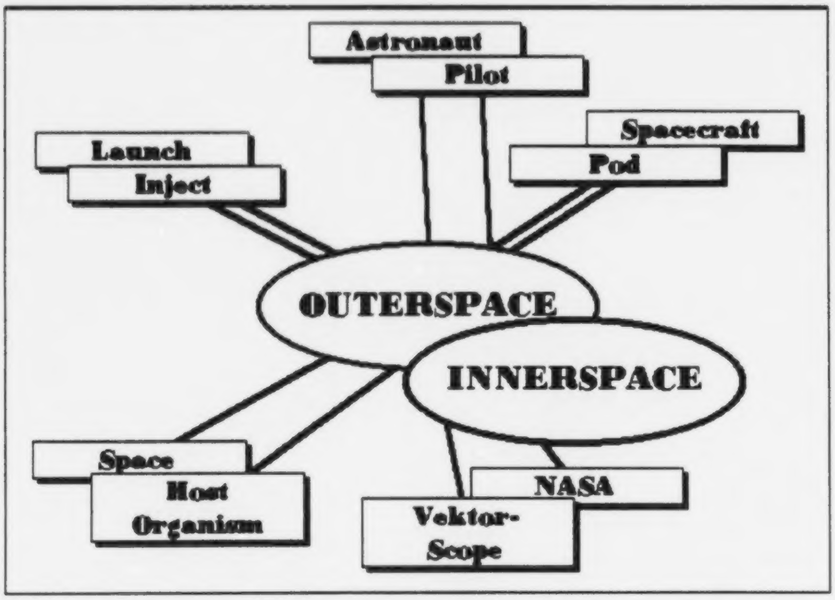

Astronaut
Pilot
Launch
Inject
Spacecraft
Pod
OUTERSPACE
INNERSPACE
Space
Host Organism
NASA
Vektor-Scope

Figure 1. Graphic Organizer for Introducing the Movie, *Innerspace*.

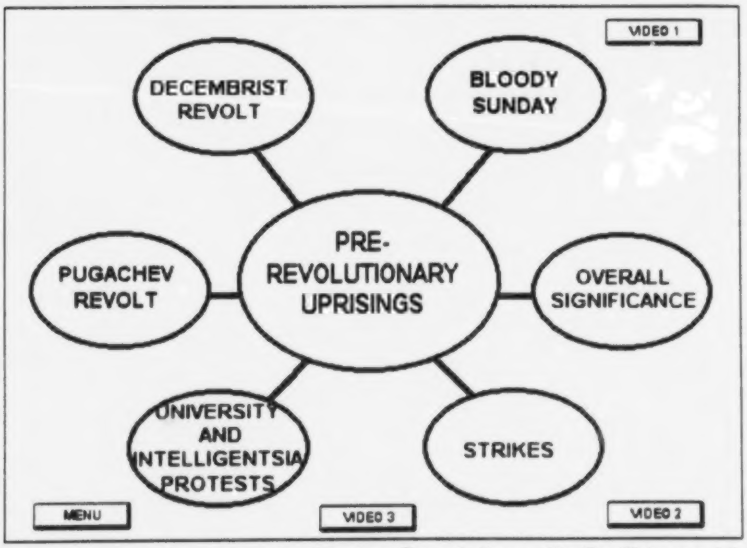

VIDEO 1
DECEMBRIST REVOLT
BLOODY SUNDAY
PUGACHEV REVOLT
PRE-REVOLUTIONARY UPRISINGS
OVERALL SIGNIFICANCE
UNIVERSITY AND INTELLIGENTSIA PROTESTS
STRIKES
MENU
VIDEO 3
VIDEO 2

Figure 2. Graphic Organizer for Russian Revolution with *Dr. Zhivago* Video.

(see Figure 4). This template provides a complete record-keeping system, along with an authoring mode wherein the author of the test can provide generic and specific feedback for each possible response in the multiple-choice test. The computer will also randomize presentation order of the test items.

Informational Database Applications

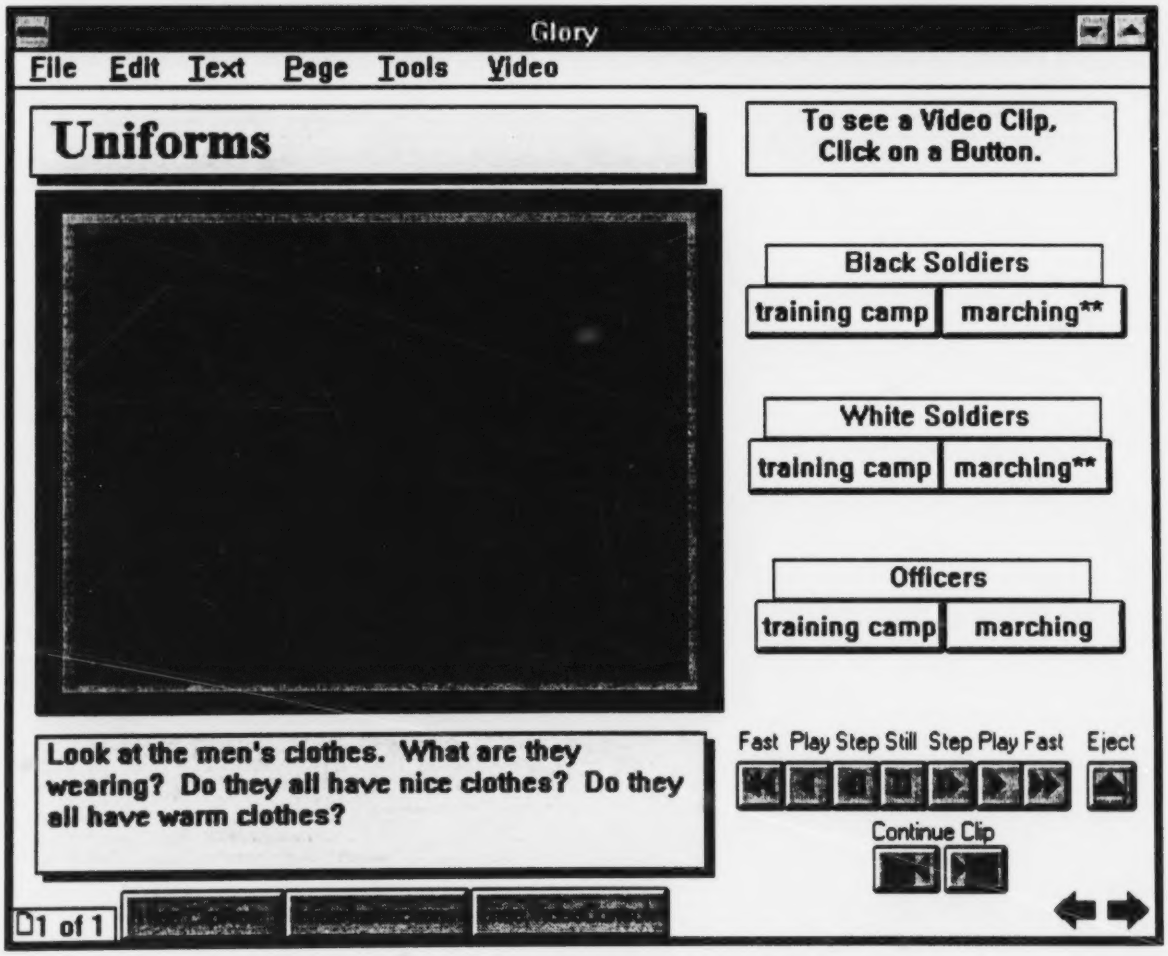
Marty Noretsky used the movie *Hawaii: Island of the Fire Goddess*, as a model for interactive informational databases. Figure 5 presents an instructional screen that allowed readers to compare facts and legends concerning how the Hawaiian islands were formed. This model, along with others developed by the Project ALIVE! staff, was used to show participants the types of applications that could be developed.

Uses of Graphic Organizers

All of the participants in the project were excited by the ability to create professional-looking graphic organizers for their instructional units. Figures 1 and 2 in this paper are examples of semantic webs, which everyone found very useful. Especially important was the fact that the nodes (box or circles at the end of the web) have "rubber band" connections to the center of the web, which allow the modes to be moved easily without redrawing of the node or line. Semantic webs such as these and Venn diagrams (see King et al., in this volume) quickly became a favorite means for teachers and their students to show relationship among concepts.

Uses of Hypermedia Resources

Participants in the project were given a *Compel* presentation that contained hypermedia buttons for linking to programs such as Microsoft's *Bookshelf*, the *Software Toolworks Multimedia Encyclopedia*, and various other hypermedia programs. Also included were buttons for linking to the basic Windows accessories and other Windows and/or DOS programs. The teachers have found some exciting instructional uses for these tools. For example,



Uniforms

To see a Video Clip, Click on a Button.

Look at the men's clothes. What are they wearing? Do they all have nice clothes? Do they all have warm clothes?

Fig 3. Compare and Contrast Activity with the Movie *Glory*.

several teachers have pasted the encyclopedia button on the background of their presentations so that the encyclopedia is always available. At first, some of us wished we could develop buttons that navigated to the exact item in the encyclopedia we wanted to use. Now, we see this as an important instructional feature in that students are repeatedly exposed to the process of finding items they want in resource materials. The content area teachers and media specialist were also able to link their curriculum materials to other programs such as *U.S. Presidents*, the *US Atlas*, and *Body Works*.

Student Uses of Hypermedia and Interactive Video

The teachers in this project have been very creative in involving students in the development and use of hypermedia. Sometimes, teachers create cooperative learning groups and have students use the computer on a rotating basis. Other times, they have students come up and use the computer during whole-class instruction activities. Several of the teachers have begun having students create their own multimedia presentations. Not surprisingly, students appear to enjoy being active creators and organizers of information. Students and teachers alike are looking forward to more student-generated projects that will be possible with increased availability of computers and projection technology and with the new *Video ClipMakers* available in *Express Author* (see King & Larkins, in this volume).

Summary

This paper provides examples of some of the instructional strategies, goals, and instructional screens teachers have developed for teaching content area subjects to deaf and hard-of-hearing students. These teachers and their students present and discuss new and old information in a contextualized, visual manner that is supported by a rich set of interactive media and authoring tools.

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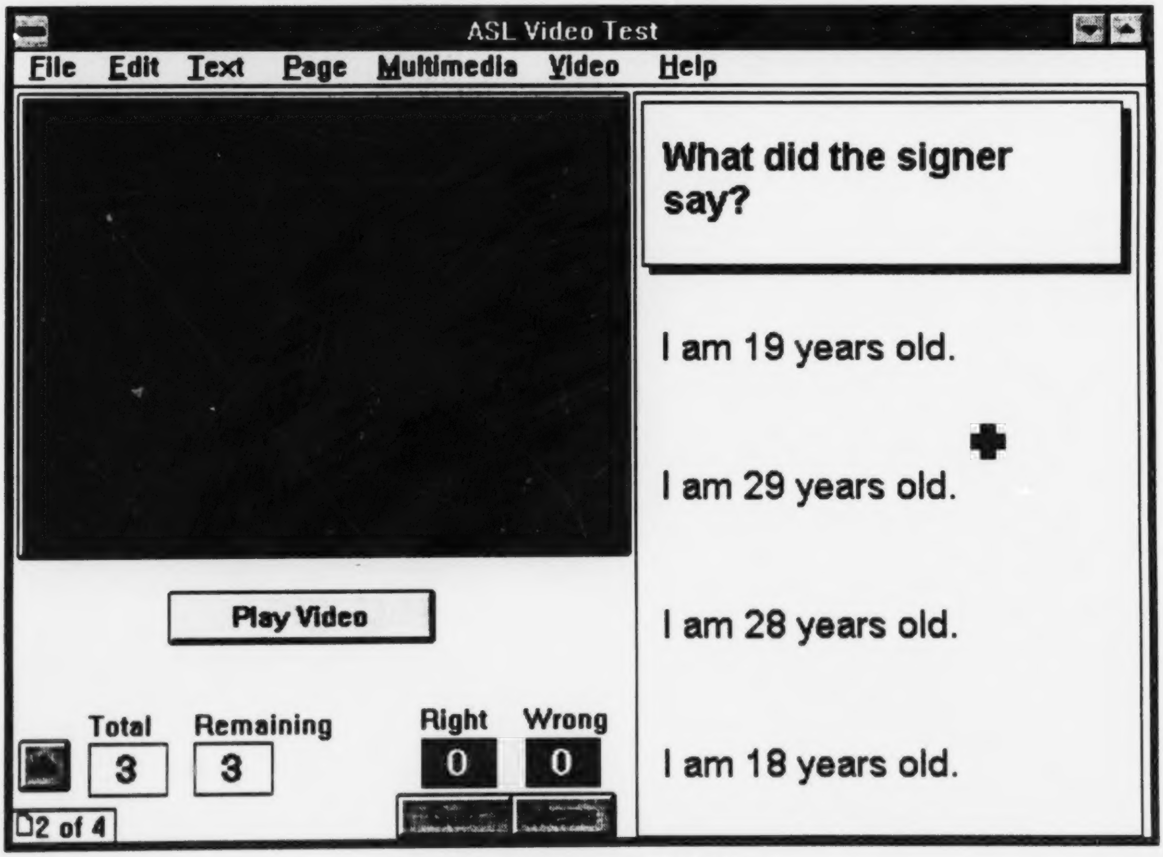

What did the signer say?

I am 19 years old.

I am 29 years old.

I am 28 years old.

I am 18 years old.

Total 3

Remaining 3

Right 0

Wrong 0

Fig 4. Sign Language Video Test.

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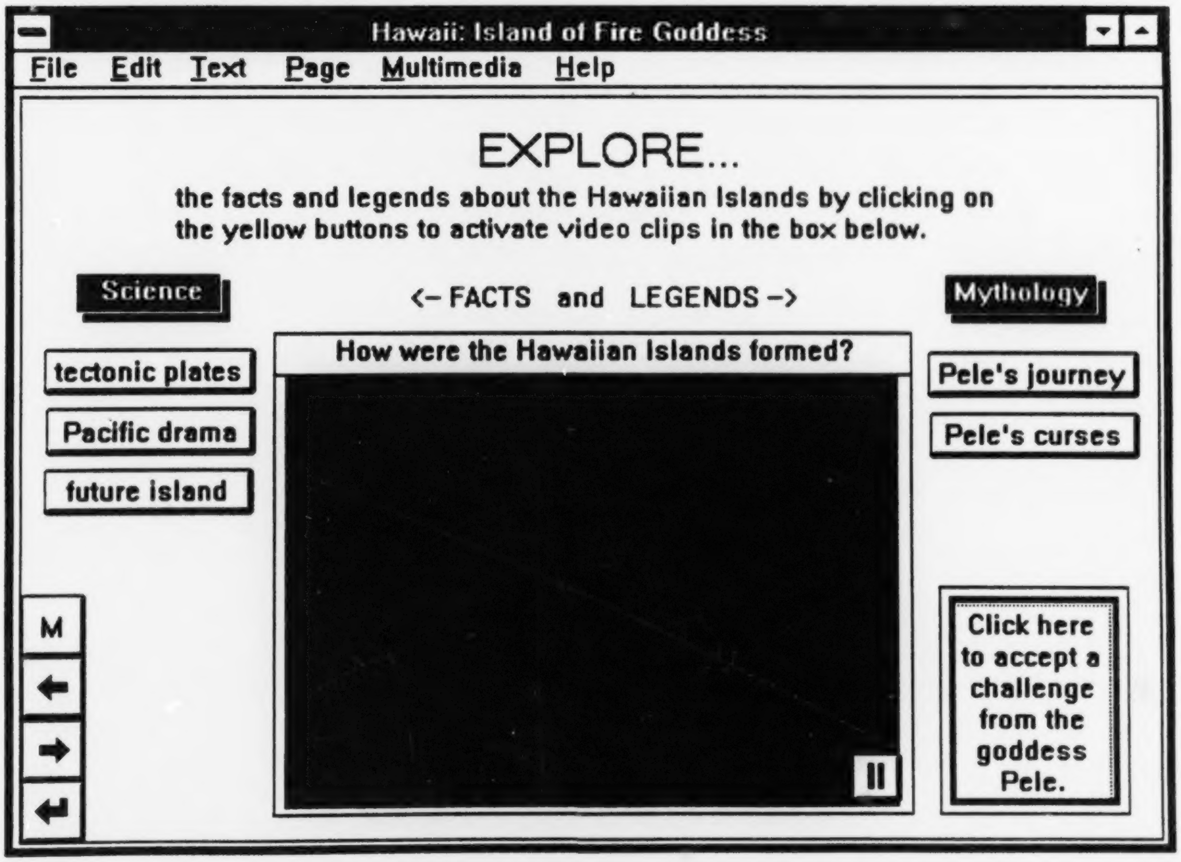

EXPLORE...

the facts and legends about the Hawaiian Islands by clicking on the yellow buttons to activate video clips in the box below.

How were the Hawaiian Islands formed?

Click here to accept a challenge from the goddess Pele.

Fig 5. Informational Screen for *Hawaii: Island of the Fire Goddess.*

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Using Technology to Enhance Geography Education: The Educational Technology Leadership Institute

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The Educational Technology Leadership Institute (ETLI), cosponsored by the National Geographic Society and IBM, took place during the summers of 1991 and 1992 at IBM training facilities in Atlanta, Georgia. A total of 64 elementary and secondary educators from 29 states learned to use technology to teach geography during two intensive 16-day institutes. Teachers were taught to use a variety of software packages and hardware including CD-ROMs, laser discs, and telecommunication devices. In addition, participants learned how to teach their peers and how to develop curricular materials that incorporate technology and geography. Each teacher was required to conduct a minimum of three full-day staff development workshops in their states during the following year. To date, ETLI participants have exceeded the minimum workshop requirements. They have conducted over 500 training sessions, reaching more than 19,000 educators, spending an average of 39 hours each during the last year!

The ETLI project was successful in preparing a cohort of technologically literate and enthused geography teacher-trainers. This article, based on ETLI evaluations, two years of telecommunications, interviews, and personal contact with participants, describes the project and suggests a variety of factors that contributed to its efficacy. It also describes a model of teacher preparation in which technology training is content-driven, not generic. The teacher-training–teachers model is not new, but as implemented in ETLI, it provided a powerful engine to create and drive the movement for technology–enhanced geography education.

The Geography Renaissance and Technology

Since 1986 geography education has been a focus of attention for the National Geographic Society (NGS). In that year it launched a campaign to form a national alliance of geography professors and teachers to enhance geography instruction in K-12 classrooms. The catalyst for the current renaissance of geography education has been intensive summer institutes and workshops held at NGS in Washington D. C and in participatory states. The institutes are organized around three elements: (a) teachers receive instruction in the fundamental themes and concepts of geography; (b) they learn innovative ways to teach geography through experiencing lessons modeled by master teachers; and, (c) they learn how to prepare and present effective geography staff development workshops. The alliances uses a teacher-training-teacher model to improve methods and materials and to reach as many teachers and students as possible (Binko, 1989).

In 1988, technology training was introduced into the institutes. Participants, called teacher-consultants upon institute graduation, were exposed to computers and made aware of the ways technology could be used to teach geography. By 1990, however, it became clear that a few hours of instruction were insufficient to meet the growing demand for staff development in using technology. A cadre of technologically literate geography educators and staff from NGS and IBM organized the Educational

Technology Leadership Institute, a technology-based geography institute for teacher-consultants.

Technology and Geography Instruction

Geography by its nature is a discipline enhanced by visualization. Maps, remotely sensed images, graphs, sketches, diagrams, photographs, spatial databases and other representations are important parts of geographic analysis (MacEachren, 1992). In fact, any information that helps individuals observe Earth's characteristics, discern patterns and spatial relationships, and gain a sense of what places are like, is essential in geography education.

Five Skills of Geography

Geography educators identify five important geography skills: (a) asking geographic questions; (b) collecting geographic information; (c) presenting geographic information; (d) analyzing geographic information; and (e) developing and testing geographic generalizations (Joint Committee for Geographic Education, 1984). Technology can be used by students to master each skill and to integrate them into a process of inquiry. A variety of software, laser disks, CD-ROMS, and telecommunications links makes geographic information, including pictures, accessible and relatively easy to collect. Geography students need to both read and create maps to find geographic relationships and associations. Technology makes cartography easy and removes the tedium of making a variety of maps while exploring data. Technology allows students to present geographic information in time lines, graphs, charts, and models easily. There are a number of geographic relationships and concepts that are abstract and difficult for students to learn, such as spatial diffusion, population growth, and geomorphic processes. They can be modeled, displayed, and explicated using technology. Complex geographic problems can be managed using geographic information systems (GIS). These technological solutions to pedagogical problems facilitate the analysis and conclusion-drawing stages of inquiry.

Teaching and Telecommunications

Communication is enhanced by technology as well. Certainly, the best way to learn something is to teach it. In geography this is especially true. Authoring programs like *Linkway* and *Hypercard*, and software that allows students to construct multimedia presentations, encourage learning and the communication of ideas. Telecommunications link students with each other, with experts, and with current information. It broadens student perspective and makes the differences and similarities of the world clear and real to them, important goals for geography instruction.

Goals and Strategies

Each ETLI consisted of two components: the intensive institute itself and follow-up support to assist participants in implementation and diffusion. The institute had two primary goals: (a) to prepare participants to use technology in their classrooms; and (b) to prepare participants to share their expertise with other teachers. ETLI teacher-consultants were to assume leadership roles in their Alliances by developing geography-technology applications and training opportunities and by becoming advocates for technology as a means of teaching geography.

ETLI Participants

Pairs of teacher-consultants from 29 states, chosen by their Geographic Alliance, attended the 16–day training. The participants were chosen for their experience and success in delivering non-technology staff development, knowledge of geography, and overall leadership. Participants came with a variety of technology experience and ability. Some were very comfortable with computers; others were not. Each participant received a computer, laser disk player, and other multimedia equipment, as well as a variety of software, to use in their classroom and to share what they learned with their colleagues in staff development workshops.

Staff

The staff was headed by a classroom teacher with long experience in geographic education, assisted by employees of the National Geographic Society and IBM. IBM provided a technical trainer who was also a classroom teacher; for the second institute NGS provided a technical assistant. Two master teacher-consultants served as staff geographer and presenter.

Structure of Institute

ETLI was held in Atlanta, Georgia, in IBM training facilities. The training site had 16 computer stations at which participants worked in pairs. Teachers were housed in apartments, four to a suite, at a site a short drive from the training facilities. Each apartment also had two computer systems. Participants were given homework assignments at the conclusion of each day to encourage practice. For example, after each pair assembled their computer, monitor, keyboard, mouse, speakers, et cetera in the training site, they had to repeat the procedure at home.

Training Philosophy and Institute Model

The ETLI curriculum was designed to reflect the links between technology and geography instruction. Instruction began with an introduction to DOS, mouse skills, and computers, and moved quickly away from technology per se and into geography. Emphasis was on learning specific software to enhance geography learning. The focus of the Institute was clearly on teaching geography using technology. The Institute employed an instructional model based on four stages of learning: (a) awareness, (b) understanding, (c) guided practice, and (d) implementation. First, the new software and/or hardware was introduced (awareness), and a model lesson using it was presented by a staff member (understanding). During the model lesson, teachers participated as if they were students. In this way teachers became familiar with a lesson they could use in their classroom as well as in workshops. Second, participants, working in pairs, were given time to explore the software at their training station (guided practice). Finally, in the evening, participants loaded the software or added the hardware to their home systems, and continued to become familiar and comfortable with the programs. Gradually, even novice technology-users became "geo-techies."

Teachers participated in and observed a number of lessons that modeled how to teach geography using technology. At the conclusion of the Institute, again working in pairs, teachers developed and modeled one-hour, staff development workshops using the software and hardware they had learned (implementation). Feedback provided by fellow participants helped to improve and polish the presentations. This summative experience provided each teacher with 15 lesson plans to use in teaching and training, built confidence, and provided experience in the joys and frustrations of presenting technology-based inservice workshops.

Evaluation

One of the strongest components of the Institute was careful attention to daily evaluations. At the conclusion of each day, participants completed an evaluation form which monitored personal level of comfort and asked questions such as "What went well today?" and "On what do you need additional help?" Each evening the staff reviewed the evaluations and adjusted the next day's agenda. This process was especially important for the first Institute; pacing, introduction of more detailed instructions, and a system of nightly staff visits to struggling participants in the second Institute made adjustments less necessary. In both Institutes, flexibility was an important component. A summative evaluation and a follow-up evaluation in 1993 has tracked ETLI participants and suggest strengths of the ETLI model.

Support

Follow-up support for participants has been provided by IBM, NGS, and the ETLI staff in two ways. During the Institute teachers were trained to use a commercial telecommunications service, America On-Line, and given an introductory free membership. This telecommunication link to staff served as the primary avenue of support for participants. Secondly, participants were given a hot-line number at NGS and IBM to call for immediate technical assistance. Participants have used both avenues to communicate with each other and staff, sharing success stories and problems, calling for assistance, and asking specific technology questions. Participants have also been supported by their state Alliances. In some cases, participants' school districts have provided technical support, staff development opportunities, and some equipment, for example, a telephone line.

An analysis of the On-Line communication for both 1991 and 1992 participants shows that most of the requests for support have been technology-based. A small yet significant number of requests have been made to the NGS and IBM staff liaisons seeking support in creating opportunities for staff development, training workshops, and equipment purchases and repairs. There have been almost no requests for help in teaching methods using technology or geography.

Some of the telecommunications are personal; most often they relate to geography. In the fall of 1993, one ETLI 1991 participant wrote a long and detailed description of the Los Angeles fires. Another sent a message asking if anyone had experience in preparing environmental impact reports to expose a local case of water pollution. Earlier in the summer, a series of reports from areas along the flooded Mississippi provided first hand reports of that human-environment interaction. ETLI 1992 participants waited anxiously to hear if their fellow teacher-consultant from Kauai survived Hurricane Iniki. One ETLI participant wrote:

> *I appreciate the connectedness we all gained through America On-Line. It was a message on-line that got me into the Arctic Project with Will Steger.... Telecommunications is used to create a network of schools and to allow them to interact with Arctic explorers up in the Northwest Territories.*

Lessons Learned

ETLI can be considered a success based simply on the number of workshops conducted by its graduates. They have conducted 589 workshops for approximately 19,200 educators. Not one ETLI graduate has failed to meet Institute expectations. ETLI graduates have had a tremendous effect in other ways as well, for example, by incorporating technology into state summer geography institutes by replicating the ETLI model. ETLI-trained teacher-consultants have presented at national conferences, worked with preservice educators and appeared before a congressional appropriations committee. They have changed their personal style of teaching and expanded the use of technology in other classrooms by writing and receiving grants. They have become geo-tech advocates, a primary Institute goal.

The success of ETLI in preparing technologically literate and enthused geography teacher-consultants may be attributed to a variety of factors:

The Nature of Geography

As discussed previously, geography is a discipline enhanced by visualization. Many geography teachers use a process of inquiry which is enriched and enabled by technology.

The Participant Selection Process

All the participants had previous experience in staff development and geography education from attending previous Geography Institutes. They were chosen by their state Alliance following clear guidelines distributed by the National Geographic Society. Choosing pairs from each state gave participants a ready network of support and a partner/collaborator.

The Training Philosophy and Institute Model

The ETLI experience proved that teaching technology through content can be successful. During ETLI a number of participants commented that they had previously received technology training but that it had not seemed relevant or useful to them. By embedding the technology training in subject matter, and by placing the emphasis on geography, not technology, interest and motivation was increased. Participants were willing to exert effort to learn technology that would make them better geography teachers, something they valued. As one teacher wrote in a list of tips about conducting geography/technology inservice workshops, "Focus on academics. Don't turn a technology workshop into a hardware and software show."

Participants commented in follow-up evaluations on the value of seeing lessons modeled during the Institute and having to prepare an inservice presentation on their own. Some found the four-staged model (awareness, understanding, guided practice, implementation) useful in planning staff development experiences.

Use of Daily Evaluations and Flexible Scheduling

Throughout both Institutes, daily evaluations helped to monitor teacher progress and maintain participants at their zone of proximal development. Participants found ETLI a stressful experience (one likened it to Navy SEALS training in the Institute evaluation), but the challenge was never so great that participants became frustrated, alienated, or lost commitment.

The Alliance Context

ETLI graduates returned to a successful and functioning Alliance structure through which they could work to arrange staff development opportunities, summer institutes featuring technology, and other activities. The Alliance network provided access to teachers interested in geography and disposed to learning new ways to teach geography. Early success in providing training to Alliance teachers gave participants the confidence to branch out to a wider and perhaps less-responsive audience.

Follow-Up Support

The level of support and follow-up provided to ETLI participants using telecommunications has been of great importance in maintaining enthusiasm, interest, and continuing commitment to geography/technology education. Not only have participants helped each other, but they have had easy access to both the National Geographic Society staff and IBM personnel. ETLI created two cohorts of teachers who remain deeply connected with each other professionally and personally, both through telecommunications and the common bond of interest in geography and technology.

Hardware and Software Donations

One of the most important ingredients in the success of ETLI must be attributed to the wealth of hardware and software participants received. This made presentation in workshops and exploration in the classroom easy.

Outcomes for Participants

Outcomes for the participants can be seen in their classrooms and their opportunities for professional leadership

Changes in the Classroom

The Institute had a profound effect on those who attended. One of the most fundamental effects was the change it produced in participants' teaching styles, classroom organization, and curriculum. As one ETLI graduate reported, " I have rethought my classroom approach. I'm allowing the students to become more independent in their search for knowledge in my classroom." Another teacher commented on the world of resource materials available to students through technology: "...ETLI has enabled me to be more of a facilitator than a lecturer. Technology has been a wonderful tool for integrating the curriculum." A teacher in Massachusetts commented, "Technology has allowed my students to be in control of their own learning and to be aware of a world that exists far from the four walls of the classroom. It is such an integral part of the program that we can never return to the way we learned before." A third grade teacher in North Carolina wrote:

> *Through the use of the computer, teaching is a much less regimented scheme of instructor-made plans to prompt the "right answers." Instead teaching/learning are mutual outcomes for both the instructor and students. Our classroom computer is no longer an incidental part of the classroom, it is the integral part of the curriculum.*

All ETLI participants recognize the value of active learning, the opportunities for discovery provided by technology-based instruction, and renewed enthusiasm and interest on the part of their students. One participant summed up experiences shared by many ETLI graduates:

> *Technology has elevated the quality of my teaching. One only has to see the reactions of my students. They are excited and involved in the learning process. I am more efficient and effective as a teacher because I can create and tailor lessons in ways that were not possible before. Students respond to what they see and hear immediately and they can create and present their own lessons. Technology provides the tools that students can relate to and I can involve them more meaningfully in their education.*

Changes in Professional Opportunities and New Leadership Roles

Many ETLI participants have been offered new professional opportunities as a result of their technical and geographic expertise. Several have become social studies coordinators and as a result now incorporate more technology into staff development. Four are now computer/media specialists. Others have become involved in curriculum development, have received appointments to state technology education committees, work as computer consultants, and teach preservice educators about geography, social studies, and technology. These graduates have a wider and more important sphere of power in which to encourage technology and geography.

More than 20 ETLI participants have written and obtained grants to purchase more equipment, software, and training opportunities for themselves and their colleagues. Many ETLI graduates used their own resources to attend two reunion and renewal workshops and have worked diligently to learn new and innovative computer-based geography techniques such as geographic information systems.

Summary

Copeland and De La Cruz (1990) found limited success in using an intensive training institute to prepare teachers to implement technology in their own classrooms and to take on staff development and advocacy roles within their school districts. They attributed the lack of success to five factors, including participants personal characteristics, an inadequate level of support, and time lag. The ETLI experience confirms the importance of two of their findings but did not indicate a time lag. A network of support for ETLI graduates may have been a crucial factor in implementation. The selection process identified individuals who were already leaders, and placed them back into a strong Alliance network that enabled them to reach other teachers. These two factors, and the unique model of teaching technology through a disciplinary base, may have contributed to the strength of ETLI.

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Computer Technology for Elementary School Teachers in Geography Education

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There are two issues that most educators and researchers would agree upon. One is that geography had been badly neglected and largely disappeared from the American school curriculum by the 1970s (Egan, 1983; Gregg and Leinhardt, 1993). The other is that as computer technology becomes increasingly sophisticated, more and more computers are being used in the field of elementary education to improve students' learning achievement (Kinnaman, 1990; ASCD, 1990; Ouyang, 1993). Teachers in elementary schools are faced with the challenge to revive geographic education. The use of increasingly sophisticated computer technology can be an effective way for teachers to face this challenge.

Awareness of the challenge

The importance of the issue of geographic literacy is now recognized at both the national and state levels. After decades of ignorance of geography education, geography became one of the five core subjects specified in the National Education Goals in 1991. By 1992, all 50 states and the District of Columbia had established alliances. Geography leaders across the country recognized that they would have to redouble their efforts to meet the National Educational Goals. Geography Education National Standards have become available now and are expected to be widely adopted by states, school districts, and schools.

However, one of the main problems of reviving geography teaching in elementary schools is the limited background of teachers (Gardner, 1986; Gregg & Leinhardt, 1993). Cirrincione and Farrell (1989) reported that of the 576 social studies teachers, 48 percent had no more than one undergraduate course in geography and at the graduate level, 64 percent had no advanced training. Gregg and Leinhardt (1993) stated that although some teachers can get training and support through such avenues as the Summer Geography Institutes organized by the state-level Geographic Alliance, many teachers have received little or no support. It is a challenging task for elementary school teachers who have been neglected to achieve the National Education Goals and have geographic education meet the new National Geography Standards.

Use of Computer Technology

The use of advanced computer technology can be one of the ways to enrich elementary school teachers' geographic knowledge and to facilitate teachers' geographic instruction. Theoretically, the presence of increasingly sophisticated computer technology in the field of education provides teachers with an intellectual tool and offers teachers a new opportunity to improve the quality of education (Solomon, 1986). Realistically, more than two million microcomputers have entered American schools, and the national ratio of student to computer has changed from 125:1 to 16:1 within the past decade. In addition, more than 10,000 educational software programs have become available for teacher and student use in the schools (Kinnaman, 1990; ASCD, 1990; Electronic Learning, October, 1993).

Geography instruction can be better suited to the use of computers than many other subjects (Fitzpatrick, 1990). Access to video and computer images emphasizes the visual content of geography. Electronic images, which can be easily and inexpensively updated, reflect more accurately than text the rapidly changing nature of the world such as political boundaries, effects of natural hazards, and climate patterns. When exploring tutorial, drill and practice, or simulation software packages, teachers discover on their own, learn and understand more. When searching with database programs, teachers can accumulate great quantities of geographic information which can be used to create new methods of instruction.

Software for Elementary Teachers

Geographic software for elementary teachers can be classified into two groups, (a) software for instruction and learning, and (b) database software for geographic information.

Software for instruction and learning

Certain geographic computer programs have been used and considered helpful for elementary teachers. For developing basic map and globe concepts, Broderbund's *Kid Pix*, Laureate's *Follow Directions*, and Weekly Reader's *Map Skills* are highly recommended to kindergarten and first grade teachers. *Kid Pix*, a creative paint program for young children, combines special effect art tools, picture stamps, sounds, and magic screen "trans-formotions" to help students create fun and unusual graphics. It can be an effective tool for younger children to create geographic symbols and learn the concept of maps. *Follow Directions* consists of two parts. Part one focuses on learning directions such as above/below, in front of/in back of/next to, behind/between, upper/lower, left/right, through/under, ordinal (1st, 2nd, 3rd), etc. A natural-sounding voice and colorful graphics make this program ideal for younger children and those with learning disabilities. Part two deals with the direction of left and right. The program can help younger children master left/right discrimination through the activities of right-hand matching, practice crossing midline, and moving objects to the left and right. *Map Skills* can be used to teach younger children basic map reading skills by following trip instructions around five maps of imaginary communities, and reinforce map reading skills by exploring distance, symbols, directions, and scale at ten different levels.

For the reinforcement of children's learning of geography, the use of Weekly Reader's *StickyBear Town Builder*, MECC's *Jenny's Journey*, and Orange Cherry's *Talking USA Map* will be helpful for second and third grade teachers. *StickyBear Town Builder* can be used to develop second graders' basic map reading skills, shapes of buildings, and other town components. It gives children experience identifying symbols on maps. *Jenny's Journey* can help students recognize and apply such map and globe concepts as area, location, climate, zones, latitude and longitude. With three different levels, students can progress at their own pace, learn to use a map index, find locations, plan a route of travel, and take a simulated drive through "Lake City." *Talking USA Map* uses both sight and sound to help children learn the names, locations, and capitals of the 50 states. It provides detailed maps of the entire United States, different regions of the country, plus individual state maps.

Those who teach in the third and fourth grade may also find it useful exploring Didatech's *Crosscountry USA*, Gamco's *States and Capitals*, and Educational Activities' *Learning about Geography, Maps, and Globes*. *Crosscountry USA*, a winner of a 1991 Parents' Choice Award, helps students develop map reading skills and apply the skills into daily life. With this program, children play the role of truck drivers to discover America. They read maps, calculate distances, estimate expenses, and plan cost effective routes from coast to coast while finding and delivering up to 52 commodities as they visit up to 180 American cities. *States and Capitals* can be used for students to identify highlighted states, to locate states within a region, to abbreviate state names using US postal codes, to look at postal abbreviations and correctly spell a state's name, to name capital cities, and to spell the names of capital cities correctly. *Learning about Geography, Maps, and Globes* offers students opportunities to interact with this program using stimulating tutorials, questions and answers, and simulations to gain an understanding of geography. The program consists of three disks:

- Disk I— *Introduction of Geography, Maps and Globes* introduces basic concepts in geography including learning about maps and globes, finding directions, land messages and water masses.
- Disk II— *Making Use of Maps* focuses on the concepts of distances on maps, symbols on maps, and latitude and longitude.
- Disk III— *Maps in Your Life* deals with the concepts of day and night, seasons on Earth, maps for many reasons, and learning about maps.

An automatic management system is included for teachers to monitor and evaluate student progress in mastering specific skills.

Beyond getting familiar with the geographic programs mentioned above, teachers of fifth and sixth grade will find it beneficial integrating MECC's *The Oregon Trail*, Broderbund's *Where in the USA is Carmen Sandiego?*, and *Where in the World is Carmen Sandiego?* into their instruction. *The Oregon Trail* is a computer simulation of the journey to the Old West via the trail carved in the harsh wilderness by 19th century pioneers. It can be used to develop students' decision making, interpersonal, comprehension, inquiry, and relevancy skills. The Deluxe VGA edition for IBM features new and improved high-resolution graphics along with digitized sound to provide a greater amount of realism and excitement. *Where in the USA is Carmen Sandiego?* and *Where in the World is Carmen Sandiego?* help students recognize and apply map and globe concepts and terms. While playing the games of Carmen Sandiego, students learn about the geography, economy, and history of the 50 states as well as world geography as they track down criminals from state to state and country to country.

In addition, PC Globe's *PC Globe/MAC Globe* and MECC's *World Geograph II* can be used to help students interpret charts, tables, graphs, diagrams, time lines, and understand the interrelationship between environment and resources in determining historical events. *PC Globe/MAC Globe* provides students with an electronic atlas of 208 countries' major city locations, political and cultural information, demographic, economic, climate and health data, travel requirements, tourist attractions, currency conversions, and country comparisons on charts and maps. The program also shows each country's flag and plays its national anthem. *World Geograph II* features full color maps, graphing capabilities, and an in-depth database with 55 categories related to 177 nations.

Database for Geographic Information

Another group of software is database programs from which teachers can accumulate great quantities of geographic information for instruction and reference. For example, Sunburst's CD-ROM *Picture Atlas of the World*, a multimedia atlas, includes maps of every nation and high-quality photos of those nations' peoples, places, and landforms. Its special features include:

- interactive political, topographic, regional, continental, and world maps in VGA format,
- more than 900 full-screen photos,
- a pop-up glossary of geographic terms,
- audio and video clips highlighting language, musical, and cultural traditions of the worlds' nations,
- pop-up captions and essays, geographic, demographic, and statistical data about every nation, and
- animations and diagrams exploring how to read a map.

Davidson's *Earthquest*, an interactive mini-encyclopedia, provides students at grade 4 and up an adventurous discovery of the earth, its people and its environment. It covers more than 150 subjects that are brought to life through dozens of interactive challenges, graphics, animation, samples of languages and music, 43 maps, and a variety of charts and tables. The Software Toolworks' *U.S. Atlas 3.0 Multimedia* and *World Atlas 3.0 Multimedia* are practical combinations of a fact book, almanac, and atlas which let teachers instantly access high quality, full-color maps and a huge database of information. The new *U.S. Atlas* MPC version includes data entry notepad, map trails, map makers, and other useful features. It provides topographical maps of all regions of the United States, city regional maps, and hundreds of bar charts and statistical maps. *World Atlas* zooms from the ocean depths to the world's largest peaks in a flash. It charts, analyzes, and compares thousands of facts and statistics in over 200 countries. The multimedia feature in *World Atlas 3.0 for Windows* provides digitized pronunciation of countries and cities, national anthems, and animated flags.

Summary

Geography education is a challenge to elementary school teachers today; however, the use of computer technology can be one of the ways that teachers can face the challenge. Exploring geographic software packages and database software can help teachers discover and create new effective methods of geography instruction.

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READING & LANGUAGE ARTS

Section Editors:
Michael P. French
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This section includes five papers which represent a variety of research initiatives enhancing the use of technology in reading and language arts. Each provides an example of the influence of technology on curriculum design and development in this subject area.

The first two by Kathryn I. Matthew and Nancy L. Williams at the University of Houston and by Mary Ellen Butler-Pascoe at the United States International University demonstrate applications of computer technology related to writing. Matthew and Williams report on the use of a HyperCard stack, *The Stages of Writing Development*, which was created for use within an elementary language arts methods course. This paper demonstrates the effects that quality modeling by education professors can have on learning in college classrooms.

Butler-Pascoe evaluates the use of the effectiveness of the computer as a means of introducing a computer based writing process into two intermediate-level ESL writing classes in a university program. Included in this design was word processing, online databases, and telecommunications applications.

The third paper in this section, by Nancy C. McClure, furthers the discussion of hypermedia integration by illustrating the relationship of whole language theory to hypermedia design. According to McClure, the use of hypermedia is a natural step in the progression of holistic, child-centered learning. Hypermedia facilitates the integration of content and the consolidation of volumes of information.

The final two papers by Antonio Fernandez with his colleagues Joseph Totoraitis and Anthony Palese, and by Jean M. Casey, report on initiatives in which colleges and universities have collaborated with local schools. In the paper by Fernadez et al., a long distance learning project is described in which students at St. Thomas University in Miami, Florida are linked with fifth grade students at Rockfield Elementary School in Germantown, Wisconsin.

In the paper by Casey, an evaluation of a project involving IBM's *Write to Read* is described. The project, called the Simi Star Project, dealt with the use of Write to Read in primary classrooms. The author reported results favorable to the use of *Write to Read*.

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understand the interrelationship between environment and resources in determining historical events. *PC Globe/MAC Globe* provides students with an electronic atlas of 208 countries' major city locations, political and cultural information, demographic, economic, climate and health data, travel requirements, tourist attractions, currency conversions, and country comparisons on charts and maps. The program also shows each country's flag and plays its national anthem. *World Geograph II* features full color maps, graphing capabilities, and an in-depth database with 55 categories related to 177 nations.

Database for Geographic Information

Another group of software is database programs from which teachers can accumulate great quantities of geographic information for instruction and reference. For example, Sunburst's CD-ROM *Picture Atlas of the World*, a multimedia atlas, includes maps of every nation and high-quality photos of those nations' peoples, places, and landforms. Its special features include:

- interactive political, topographic, regional, continental, and world maps in VGA format,
- more than 900 full-screen photos,
- a pop-up glossary of geographic terms,
- audio and video clips highlighting language, musical, and cultural traditions of the worlds' nations,
- pop-up captions and essays, geographic, demographic, and statistical data about every nation, and
- animations and diagrams exploring how to read a map.

Davidson's *Earthquest*, an interactive mini-encyclopedia, provides students at grade 4 and up an adventurous discovery of the earth, its people and its environment. It covers more than 150 subjects that are brought to life through dozens of interactive challenges, graphics, animation, samples of languages and music, 43 maps, and a variety of charts and tables. The Software Toolworks' *U.S. Atlas 3.0 Multimedia* and *World Atlas 3.0 Multimedia* are practical combinations of a fact book, almanac, and atlas which let teachers instantly access high quality, full-color maps and a huge database of information. The new *U.S. Atlas* MPC version includes data entry notepad, map trails, map makers, and other useful features. It provides topographical maps of all regions of the United States, city regional maps, and hundreds of bar charts and statistical maps. *World Atlas* zooms from the ocean depths to the world's largest peaks in a flash. It charts, analyzes, and compares thousands of facts and statistics in over 200 countries. The multimedia feature in *World Atlas 3.0 for Windows* provides digitized pronunciation of countries and cities, national anthems, and animated flags.

Summary

Geography education is a challenge to elementary school teachers today; however, the use of computer technology can be one of the ways that teachers can face the challenge. Exploring geographic software packages and database software can help teachers discover and create new effective methods of geography instruction.

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Authentic Uses of Technology for Curriculum Planning within a Language Arts Curriculum

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The incorporation of technology into teacher preparation programs is an important step towards implementation into the classroom (Johnson & Harlow, 1993; Wright, 1993). Since teachers tend to teach as they are taught, they need to use computers to facilitate their learning. Although this integration of technology has been strongly advocated, research conducted by Handler (1993) found few examples of this practice in college methods courses. This is unfortunate as respondents of Handler's study reported frequent modeling of technology in methods courses led to actual classroom use with children. Although many teacher preparation programs do include an introductory computer course, students see little modeling of technology by education professors. Therefore, students often do not apply this knowledge in classroom situations.

Realizing the importance of this modeling of computer use in education methods courses a HyperCard stack, *The Stages of Writing Development,* was created for use within an elementary language arts methods course. The purpose of this stack was to present information about the process of writing and expose preservice teachers to authentic writing samples of young children. Specifically, the students will have the opportunity to read about and view samples of early writing, invented spelling, and composition. Initially this stack will be used in the methods course to present the material. For the remainder of the course, it will also be available in the computer resource room as a reference source for a future project.

Theoretical Framework

Cooper (1993) traced the shifts in designed instruction from behaviorism to cognitivism to constructivism as it applies to technology. These shifts began with the behaviorist influence on instructional design which resulted in computer programs concentrating on mastery of basic skills through the use of positive reinforcement. These programs, which presented the material in small, manageable chunks, were limited by their concentration on isolated skills. The second shift focuses on the cognitive theory of learning. Here the information is related to knowledge already possessed by the learner. Learning is then linked to this prior knowledge in semantic webs that facilitate retention of the material and easy access. These programs present the knowledge to the learner as an interconnected whole rather than parts. The present shift is to constructivism. In this paradigm the focus is on the the learner's personal construction of knowledge rather than knowledge being presented to the learner. Learning is accomplished through personal discovery driven by intrinsic motivation. These programs provide the learner with access to large databases, or networks of information, and interactive simulations. Therefore, as these paradigms influence technology, the instructional designs change to accommodate them.

For the purposes of the creation of the Stages of Writing Development, we were influenced by both the cognitive and the constructivist theories of learning. We chose a hypertext document because it allowed us to organize and store information in a format representative of cognitive structure. Further, it allows information to be accessed in a nonlinear,

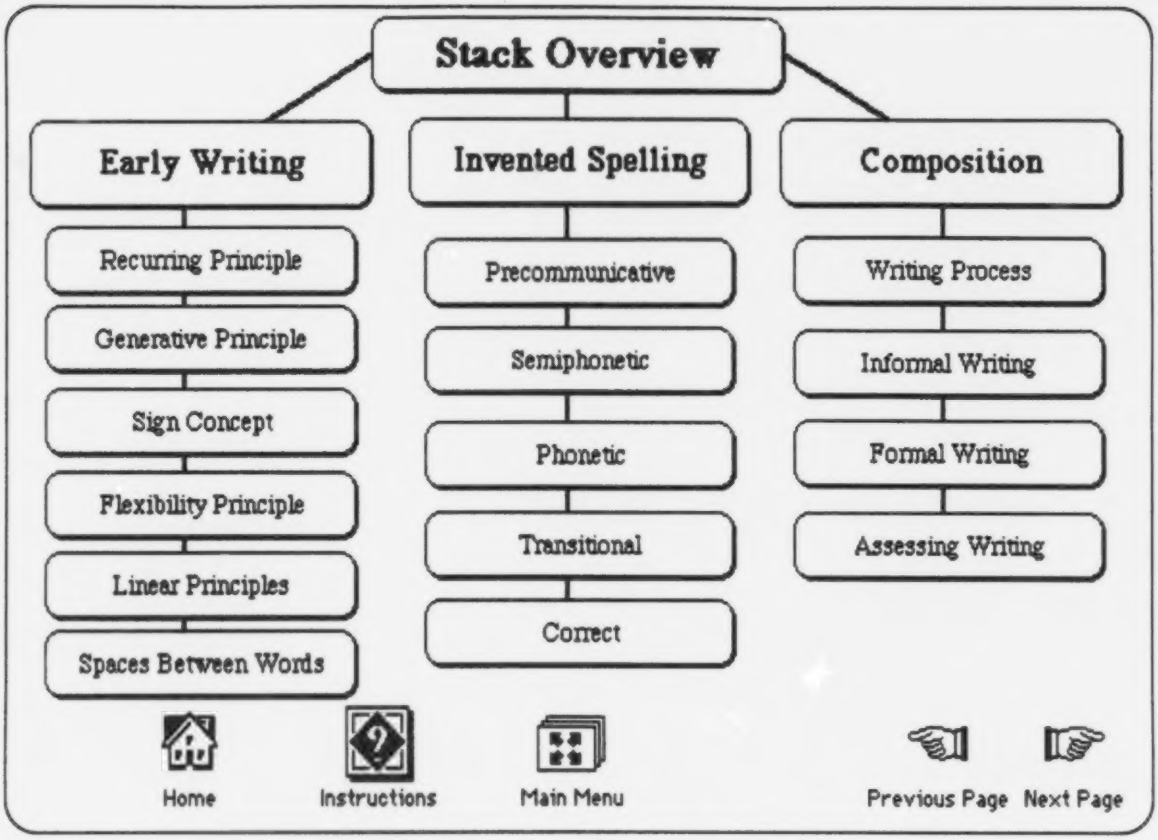

Stack Overview
Early Writing
Invented Spelling
Composition
Recurring Principle
Generative Principle
Sign Concept
Flexibility Principle
Linear Principles
Spaces Between Words
Precommunicative
Semiphonetic
Phonetic
Transitional
Correct
Writing Process
Informal Writing
Formal Writing
Assessing Writing
Home
Instructions
Main Menu
Previous Page
Next Page

Figure 1. Stack Overview.

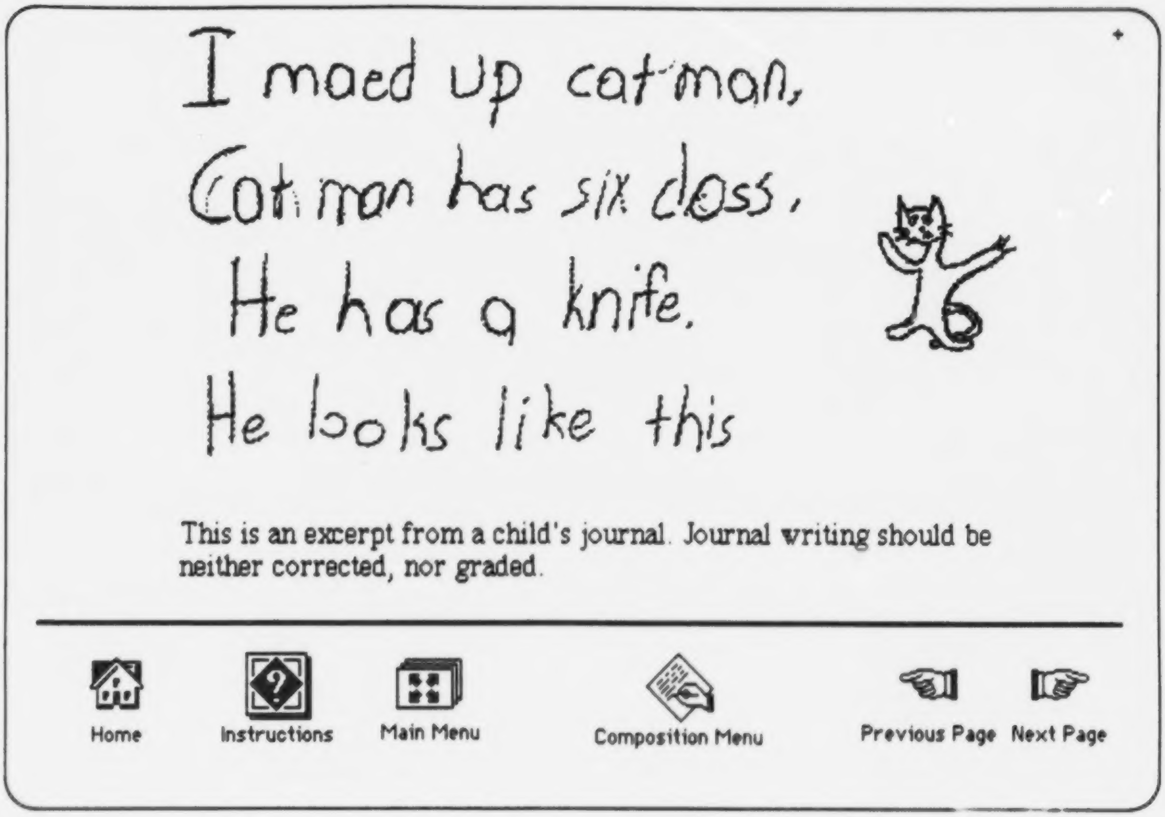
associative manner through semantic maps. These maps are reflective of cognitive thought which can be represented in hypertext with its links and nodes structure (Jonassen, 1988; Park, 1991).

As constructivism requires personal construction of knowledge, hypertext allows the user to take an active role in this process. Additionally, hypertext allows for varying degrees of learner control which effects both motivation and self-learning (Park, 1991). The amount of learner control that is provided should depend on the knowledge base of the learner and the information presented. Learners with a great deal of knowledge on the topic need little control and benefit from being able to access the information in a way that is most beneficial to them. However, learners with lesser knowledge may need assistance as they access the information. As they acquire knowledge of the topic and desire more information on a particular section, they are able to choose their own paths through the material.

Content

The stack consists of four separate stacks each with their own focus: 1) Introduction, 2) Early Writing, 3) Stages of Invented Spelling, and 4) Composition. Each section is composed of subsections that provide information about the writing process and are accompanied by authentic writing samples which illustrate the developmental stages of writing.

The beginning stack presents an overview (Figure 1) of the material contained in the stacks and instructions for navigation through them. The Early Writing and Stages of Invented Spelling stacks are based on information from Temple, Nathan, and Burris (1982). In Early Writing six different concepts are examined: recurring principle, generative principle, sign concept, flexibility principle, linear principles, and spaces between words. The Stages of Invented Spelling includes: precommunicative spelling, semiphonetic spelling, phonetic spelling, transitional spelling, and correct spelling. The last section on Composition is the largest and has numerous subsections. This stack is based on information from Thompkins (1990), and contains information on: the writing process, informal writing, formal writing, and assessing writing performance. Additionally, at the conclusion of each section the user may choose to participate in a short multiple choice quiz. This serves as a metacognitive assessment of their comprehension of the material.



I maed up cat man,
Cat man has six doss.
He has a knife.
He looks like this

This is an excerpt from a child's journal. Journal writing should be neither corrected, nor graded.

Figure 2. Journal Writing.

Stack Design

Careful attention was given to the card design and navigational links to prevent user disorientation. If the student becomes confused, their attention is diverted from learning the material to finding their way in the stack. Therefore, numerous features were incorporated into the stacks to facilitate movement through them.

Card Design

The card designs are used consistently throughout the stacks. The same background fields and buttons were used in the stacks to assure that they would be in the same location on every card. The section name, displayed in the top left corner of the card, serves as an orientation aid for the user. Care was taken to make sure that the cards do not overwhelm the reader with print. Short writing samples are placed in the center of the card with the corresponding information directly below, as shown in Figure 2. Longer samples are on the cards just after the information. Using consistent formats allows the users to focus on the information rather than its location.

Navigational Tools

To facilitate movement through the stacks, the first stack contains a main menu, a stack overview, and instructions all of which can be accessed from any card in the stacks. The main menu and overview show the users the stacks' layouts and provide them with immediate access to the stacks and their sections. An in depth look at the stacks is provided by the overview which lessens cognitive confusion and gives students a reference point should they get lost in the stack (Park, 1991).

Navigation through the stacks is facilitated by the buttons being placed in the same position on each card. The next page buttons provide a structured logical path through the material. Additionally, the other buttons give the students nonlinear access to the material. By using these buttons the students can structure their learning in a way that is meaningful to them.

Conclusion

When designing the stacks careful attention was paid to instructional design principles advocated by Cates (1992). Creating our own stacks allowed us to make sure that they fit into the curriculum being taught and were tailored to the specific needs of the course. As the needs of the students and the course requirements change, the stack can be altered to accommodate these needs. As students collect children's writing samples these can easily be added to the stacks. This database was designed to be used as both an instructional tool and as a resource for the students. Integrating it into the course and having it available to the students in the computer resource room makes it a valuable reference. Quizzes interspersed through out the stacks enable the students to monitor their comprehension as they read. If needed, they may return to the stacks to review the material. The quizzes and their collection of writing samples will encourage the students to become active receivers of information and will foster their personal construction of knowledge. As they gather children's writing samples, they will be able to develop connections between theory and practice. Therefore, their writing sample collections will help them integrate the stages of writing development into a complete picture and become more computer literate.

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The Effects of Introducing Computer Technology Into a University-Level English as a Second Language Writing Course

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The continuous reevaluation of theories and methods of second language teaching in the past decade resulted in fundamental changes in English as a second language (ESL) classroom practice. Current methodology with a focus on interactive approaches to communicative classroom instruction, the individuality and varying learning styles of students, the function and structure of language, content-based and task-based instruction, and innovative uses of technology (Morely, 1987; Fotos and Ellis, 1991; and Nunan, 1989) reflects these changes. As a consequence of a paradigm shift in writing instruction from a product to a process orientation, grammar is addressed on an individual basis within the context of student writing rather than solely as class lessons on a prescribed sequence of structures.

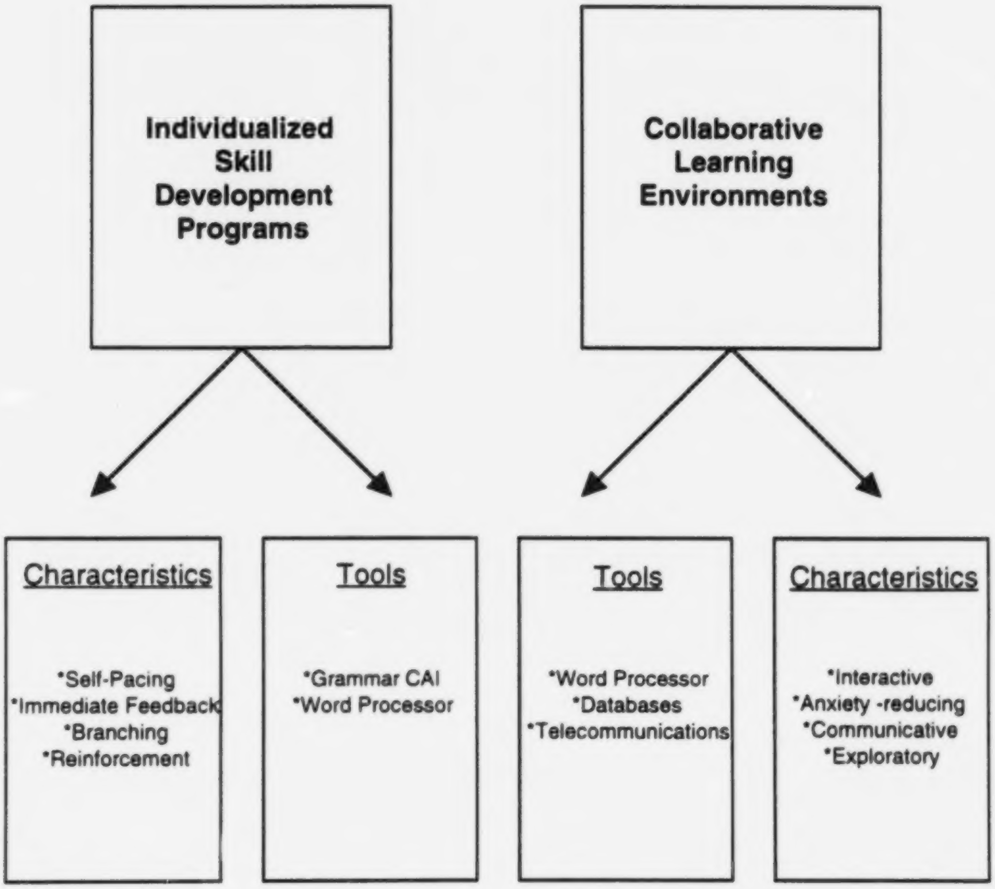
Paralleling changes in approaches of language teaching, computer-assisted language learning (CALL) software moved from a behavioristic to a humanistic theoretical framework. It was against a backdrop of humanistic psychology and communicative linguistics that a demand for interactive and communicative uses of technology for language teaching developed (Stevens, 1989). The interactive quality of computers has been exploited to meet the needs of varying learner styles (Chapelle and Jamison, 1986; Rubin, 1984). Databases, word processors, and telecommunication networks are viewed as having greater potential impact on language learning than either traditional or communicative CALL software (Stevens, 1989).

Of particular interest to this study is the computer's ability to provide both a creative learning environment that facilitates the writing-as-a-process approach and skill development programs for grammar instruction (Engberg, 1986; Mehan and Riel, 1986; Piper, 1987). Cohen and Riel (1986) reported positive results from the use of computer networks to provide authentic audiences for student writing. Other studies indicated improvement in motivation and pride of authorship (Phinney, 1989; Engberg, 1986) and reduction in anxiety (Berens, 1986; Piper, 1987).

The potential power of the computer in education derives from its ability to provide a functional learning environment as well as individualized instruction (Bork, 1987; Mehan, Miller-Souviney, and Riel, 1986). The National Task Force on Educational Technology (1986) concluded that the computer was uniquely suited for education because it could be programmed to adapt to the needs of each student, supplying corrective advice and self-paced practice and could be utilized in interactive computer-based learning environments.

The purpose of this study was to evaluate the effectiveness of an instructional model used to introduce a computer-based writing process into two intermediate-level ESL writing classes of a university program. The classes consisted of fourteen female and ten male undergraduate and graduate students from seven different countries. The writing curriculum was based upon an instructional model that included two components: a collaborative writing environment that utilized word processing, on-line databases, and telecommunications and a component that promoted individualized skill development through

An Instructional Model of a Computer-Based ESL Writing Class


Individualized Skill Development Programs
Collaborative Learning Environments
Characteristics
•Self-Pacing
•Immediate Feedback
•Branching
•Reinforcement
Tools
•Grammar CAI
•Word Processor
Tools
•Word Processor
•Databases
•Telecommunications
Characteristics
•Interactive
•Anxiety -reducing
•Communicative
•Exploratory

grammar programs and word processing.

Method

This study examined the effects of the dual-approach curriculum which incorporated collaborative group activities and individualized skill development instruction at each stage of the writing process from brainstorming to publication of students' writing. Major elements of the curriculum included use of telecommunication networks for pen pal letters, on-line databases for small group projects, word processors for prompted writing and composing, and individualized computer-based grammar practice based upon diagnostic testing and errors indentified in the context of each student's writing.

Qualitative and quantitative data were gathered to evaluate the effectiveness of the computer-based curriculum on writing achievement. The qualitative data were collected from questionnaires, interviews and direct observations. Pre and post-term questionnaires were administered to the students with follow-up interviews conducted by the researcher. Of special interest to this study were possible effects of a computer-based curriculum on students' perceptions of their writing ability and self-confidence. Questions to assess any changes in these perceptions were included on both the pre-term and post-term questionnaires. The post-term questionnaire asked students to evaluate the helpfulness of the various computer activities in assisting them in the improvement of their writing skills. Post-term interviews also focused on student opinion of effective uses of the computer throughout the course.

Observations of the instructors and students working with computers in the classroom and language lab were made by the researcher and an outside observer. Particular attention was given to the interaction between the students and between the students and the instructor as they participated in computer-based activities.

Quantitative data were collected to evaluate both components of the model. Researcher-made pre and posttests were given on each computer-based grammar exercise a student completed. The decision as to which program an individual was assigned was determined by diagnostic testing or analyzing errors that appeared in the student's writing. A t-test of paired samples was used to analyze the mean gain scores of pre and posttests on each computer-based grammar unit.

Pre-term and post-term student compositions were used for assessing overall improvement in student writing skills. The results offered evidence as to the effectiveness of composition-related activities such as on-line database projects, pen pal letters via telecommunication networks, and desk top publishing and prompted writing with word processors in combination with individualized grammar practice in contributing to improved writing ability. The holistic scoring guide of the TOEFL Test of Written English was used to evaluate the pre and post-term compositions and an analysis of gains of the pre and post-term mean scores was conducted.

Additionally, the composition gain scores of students in the study group were compared to those of a class of fourteen students enrolled in the traditional intermediate-level writing and grammar course of the same ESL program prior to the introduction ot the computer-based writing process into the curriculum.

Findings

The students scored impressive gains on their compositions. The mean score on the pretests was 2.45 on a scale of 1 to 6. This score was between level 2 defined by the TWE scoring guide (1989:26) as that which "suggests incompetence in writing" and 3 which "demonstrates some developing competence in writing, but remains flawed on either the rhetorical or syntactic level, or both." The post-term mean score of 3.86 neared a score of 4 which "demonstrates minimal competence in writing on both the rhetorical and syntactic levels. The mean score gain of 1.41 from pre-term to post-term indicated significance at the $p < .001$ level.

In comparison, students using the traditional curriculum prior to the inclusion of computers and process writing into the program had a pre-term mean score of 2.42 and a post-term mean score of 3.28. While the resulting .85 gain was significant at the $p < .001$ level, it was a half-level lower than the 1.41 gain achieved by students in the study group. An analysis of the difference in mean gain scores of the two groups using a t-test of independent samples showed significance at the $p < .01$ level.

Students in the study group took tests before and after performing weekly computer exercises on specific structure items. The mean gain scores on these weekly structure tests were compared using a t-test of paired samples. Significant gains ranging from $p < .05$ to $p < .001$ levels were established for all tests.

Interesting findings emerged from student appraisals of their writing ability and degree of self-confidence. When the students were asked to rate their writing ability on a scale from 5 - "excellent" to 1 "poor," the ratings were significantly higher on the post-term questionnaire than those for the identical item on the pre-term questionnaire. A difference of 1.90 between the pre-term mean score of 2.00 and the post-term score of 3.90 indicated significance at the $p < .001$ level. A similar trend was found when the students were requested to rate their level of self-confidence in writing in English. The difference of 1.90 between the pre-term mean score of 2.38 and the post-term mean score of 4.28 on this item indicated a significant increase in student self confidence in composing in English.

In judging the effectiveness of the computer activities included in the curriculum, student opinion was sought on the post-term questionnaire. Students were asked to rate each activity on a scale of 5 - "very helpful" to 1- "not helpful" according to its degree of assistance in the development of their writing skills. The students' evaluations were very favorable toward all of the computer-based activities used during the term. The mean scores on this five-point scale were the following: 4.52 for word processing, 4.23 for grammar exercises, and 4.04 for both telecommunication networks and on-line databases. The students reiterated these findings in follow-up interviews conducted by the researcher. When asked which presentation mode they preferred for prompted writing exercises, only two students indicated a preference for using paper, and sixteen favored utilizing the word processor for this function.

Based upon interviews with the instructors and observations of the researcher and outside observer, several advantages of a computer-based writing process were identified:

1. Word processors allowed students to easily revise and edit their compositions, thereby avoiding tedious recopying.
2. Students demonstrated pride in producing a legible, attractive paper and in developing word processing skills.
3. Student enthusiasm for writing with word processors resulted in their spending additional time on revisions outside of class hours.
4. Instructors could view students' writing on the monitors without interrupting their composing process.
5. With computer-based skill development taking place in the lab, more class time and teacher attention could be devoted to writing tasks.
6. There was an increase in student interaction and oral communication as students collaborated on word processing and on-line database projects.
7. Writing pen pals via a telecommunication network provided students an authentic audience and acted as a motivating force for revising and editing.

Conclusion

The findings of this research support the conclusion that the two components of the instructional model, individual-

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ized skill development programs and collaborative learning environments, provide an effective framework for a computer-based writing curriculum at the university level.

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Whole Language Philosophy in a "Stack": Embodiment in Hypermedia

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A whole language philosophy embodies the belief that children learn through meaningful experiences with the four language arts—reading, writing, speaking, and listening. Whole language theorists believe the best strategies for teaching children are those that provide opportunities for learning through application and integration of the language arts across the curricula (Goodman, K. S., 1989; Goodman, Y. M., 1989; Newman & Church, 1990; Pearson, 1989; Reutzel & Hollingsworth, 1988; Watson, 1989). This philosophy is rooted in constructivist theory which holds that learners create meaning for themselves by accessing and utilizing their own background knowledge, or schemata, to make sense of incoming information (Abbott, Black, & Smith, 1985; Anderson, 1984; Bransford & Vye, 1989; Kamii, 1991; Marsh & Kumar, 1992; Nelson, in press; Perkins, 1991; Rumelhart, 1985; Scardamalia & Bereiter, 1991; Spiro, Feltovich, Jacobson, & Coulson, 1991). Thus, when teachers effectively implement strategies based on whole language materials relevant to children's interests are used. Children are encouraged to create meaning by making connections to their own schemata and crossing discipline boundaries in order to discover new information (Goodman, K.S., 1989; Goodman, Y. M., 1989; Reutzel & Hollingsworth, 1988; Routman, 1988).

Thematic instruction is a basic tenet of whole language teaching. To illustrate, consider a story in a 4th-grade text about a young boy in the late 1800's who became a famous bicyclist. This story could easily become the center of a thematic unit. Bicycling is relevant for most 4th-grade children, and the context of the story provides natural avenues for exploration (Routman, 1988). In this whole language scenario, the teacher would become the facilitator (Reutzel & Hollingsworth, 1988) in helping students learn about (a) life in the 1800's and why bicycling was a natural sport for people of that era (history), (b) other places in the world where bicycling was and is an exciting sport and/or an important means of transportation (geography), (c) benefits of cardio vascular exercise (science and health), and (d) the importance of safety equipment (health and safety). In whole language, teachers act as resource persons and provide opportunities for students to expand their investigations into broader themes—such as sports, in this example—and to collaborate in their investigations, data collection, thinking, and problem solving. In units of this type, students naturally utilize reading, writing, speaking, and listening skills in the course of their studies.

Hypermedia Instruction

As does whole language, hypermedia instruction can promote natural application of the language arts in creating meaning across discipline boundaries. Hypermedia instruction involves the utilization of an integrated information environment packaged with video, audio, graphic, and textual components that are accessed through a computer (D'Ignazio, 1987; Hammond, 1989; Marsh & Kumar, 1992; Scheidler, 1993; Thorp, 1993). As does the whole language philosophy, hypermedia instruction has developed as a result of the belief that students who become actively involved in learning construct their own knowledge frameworks, make stronger connections to their prior knowledge and utilize higher level thinking skills, which results in more effective learning (Bransford & Vye, 1989; Marsh & Kumar, 1992; Nelson, in press; Perkins, 1991; Scardamalia & Bereiter, 1991; Scheidler, 1993; Spiro et al., 1991; Thorp, 1993). Hypermedia instruction promotes topic exploration as well as the crossing of discipline boundaries which promote the natural use of language arts skills. In this context, hypermedia instruction can be implemented either either by utilization of prepackaged units or the development of student-made units.

An example of a prepackaged unit is the Jasper Series. Developed by the Cognition and Technology Group at Vanderbilt University (CTGV, in press), the unit poses various mathematical problems to be solved within the context of stories. The stories in this package are video-based adventures that challenge students to utilize effective communication skills, cooperative learning strategies, and specific knowledge of science, math, history, and geography to define and solve the problems.

Alternately, when students develop their own stacks they produce presentations that draw from many disciplines to represent their own understanding of topics. As an illustration, students enrolled in Kay Scheidler's (1993) English classes created stacks on topics of their own choosing that incorporated readings from science, history, and literature; laser disc segments, graphics, and audio; and oral history, mythology, and surveys, among other sources. One study on "Dance" included segments on history, choreography, current ballet, and the emotional aspects of dance; a stack on "Immortality" consisted of biological information, prose and poetry on death, mythology, and survey data.

Implications

Proponents of whole language philosophy believe that the best teaching strategies are those that emphasize holistic approaches to students' active involvement in their own meaning making. Thus, not only are teaching and learning defined differently than they were in the past, teachers and learners themselves assume new roles and responsibilities. Whole language teachers believe that learning is a natural process for children. These instructors provide opportunities rather than lecturing and distributing worksheets. In these situations, learners no longer depend on the teacher's ultimate interpretation of text, but connect with their own experiences, bringing them to the learning situation and actively applying them to new ideas and endeavors.

Hypermedia instruction embodies all that whole language advocates. The technology enables the teacher to provide either a prepackaged investigative environment within which students can learn or the framework upon which students can design their own learning. In whichever direction the hypermedia teacher moves, the components of whole language are addressed. Learners control and actively participate in their learning. Thinking necessitates collaboration. Integration of content across the disciplines occurs naturally. Application of the language arts is meaningful and purposeful, and teachers direct and encourage.

Thus, the use of hypermedia technology in whole language classrooms is a natural step in the progression of holistic, child-centered learning. Because hypermedia technology facilitates the integration of content and the consolidation of volumes of information, it will become a natural foundation for whole language classrooms.

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Exercising the Language Arts, Long-distance, through Print, Video, and the US Mail

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The Miami-Wisconsin Project links fifth graders in Rockfield Elementary School, Germantown, Wisconsin, with university Education students in St. Thomas University, Miami, Florida. Each undergraduate Education major creates a special lesson for his or her assigned student, and the lesson is taught, one-to-one, by an exchange of friendly letters, print information, and videotapes. The underlying goal of this on-going, eight-year-old Project is the promotion of literacy by exercising language arts skills (reading, writing, speaking, and listening). The characteristics of the Project, however, also offer opportunities for instruction and growth in teacher training, individualized instruction, long-distance learning, and multi-cultural education.

Literature Review and Components of the Project

One of the major components of the Miami-Wisconsin Project is writing, a language arts skill that helps in the personal development of children for fostering the development of literacy (Graves, 1983). For children to become better writers, they must practice: children are motivated to write more, improve their writing, and develop a greater sense of community through writing at every grade level (Blake, 1992). There is one special type of writing, exchanging letters, that is highly motivational: the author can use imagination to share thoughts and feelings with a friend (Veidemanis, 1982). A literature search provided three stimulating educational projects that incorporate letter writing: sixth graders in one middle school exchanged friendly letters with pre-service teachers at a university (Crowhurst, 1992); teachers and students exchanged correspondence within classrooms to exchange ideas based on books they read (Graves, 1989); and, a mail system was proposed by which students in one school can communicate directly with each other through computers (Bruce, Michaels, & Watson-Gegeo, 1985). Effective literacy instruction, however, demands more than writing. Listening and speaking are also important to fostering literacy (Goodman, 1986; Smith, Goodman, & Meredith, 1970). In fact, there is a strong link between oral language development and success at reading and writing (Loban, 1963). And, in a broader sense, it is believed that social interaction is important to all aspects of learning (Bruner, 1966). We can conclude, then, that a variety of communication modes is effective in achieving the primary goal of the Project: the promotion of literacy. This multi-sensory approach can be further enhanced by using new technologies such as, for example, television, another component of the Miami-Wisconsin Project.

Television is an expression of today's youths and students often find this mode of communication motivational or, at least, comfortable to use. This medium, therefore, can be a powerful instrument for learning (Ohler, 1991; Carlisle, 1987). A literature review provided three documented programs that successfully use televised images: 1) videotapes distributed to parents in remote locations in Western Australia were found to be effective in motivating students to learn and in promoting general knowledge (Western Australia Education Department, 1983); 2) the Vallecito Middle School in San Rafael, California, used video production techniques with positive changes in learning attitudes and behavior (Dixie Elementary School District, 1984); and, 3) media projects (including slide-tape, video, film, and filmstrip) used in the language arts curriculum of fifth and sixth graders at the University of Wyoming Lab School showed an increase in student interest and motivation. The results of this project also showed that reluctant learners became more involved in language activities. Increases in reading and language arts achievement test scores were also noted (Kasakow & McClurg, 1984). Today, the use of video and televised images in Education is increasing through a concept known as Long Distance Learning (LDL).

LDL is when students are in one location, and the teacher (or resources) are in another. At the most rudimentary level, learning takes place from the exchange of printed information through the mail (Ohler, 1991). Increasingly, distance learning includes computers, interactive video, satellites, and other media that link classrooms that are far apart. It is widely used in various countries, namely Japan, England, Australia, and the United States. In the United States, television has been the principal mode of delivery in LDL, and has been used primarily to serve one student population: the adult learner (Timpson & Jones, 1989). The Miami-Wisconsin Project includes LDL as one of its components, but expands the concept by having an exchange of print information and televised images between elementary school children and university Education majors.

History of the Miami-Wisconsin Project, Characteristics of the Two Sites, and Procedures

The basic idea to link Wisconsin fifth graders with Miami Education students originated in 1985, during a long-distance telephone conversation between Joseph Totoraitis, then a fifth grade teacher at Rockfield Elementary School in Germantown, Wisconsin, and Antonio Fernandez, Associate Professor of Education at St. Thomas University in Miami, Florida. Although Totoraitis left the classroom to become the Rockfield School principal in 1989, he maintains an interest in the Project and has found other elementary teachers to continue in his place. Anthony Palese, the fifth grade teacher at Rockfield Elementary School, has been working on the Project for the past three years. The Project is regularly critiqued by Palese, Totoraitis, and Fernandez, through long-distance telephone, letters, and faxes.

Rockfield Elementary School is approximately twenty-five miles northwest of Milwaukee, and has the highest percentage of two-parent families in the Germantown School District; working parents either commute to Milwaukee or work in the local Germantown area (several of the families own working farms). The elementary school has classes from early childhood to fifth grade; there are 230 students and all are bussed to school. Over 90% of the student enrollment is considered middle class white. The ethnic composition of this group includes descendants of German, Irish, Polish, and Scandinavian immigrants. Other groups represented in the school include six hispanics, four American blacks, two American Indians, and one asiatic. There are no ethnic minority teachers in the school, nor will there be any at the middle school where the Rockfield students go after fifth grade.

Palese's thirty-three fifth graders reflect the general school population. His self-contained classroom has excellent teaching resources: two MacIntosh computers, two Apple II gs computers, one printer, a scanner, an overhead projector, a camcorder, a television monitor, a VCR, and a still camera. Palese teaches the standard fifth grade subjects (social studies, science, health, math, reading, and language arts). He readily utilizes the various teaching resources in his room. The fifth grade students are with their teacher from late August until early June of the following year.

In August, after the first week of school, Palese consolidates his class roster and writes comments next to the names (e.g., "gifted," "learning impaired," "regular student," "likes sports," "just moved here from Chicago," etc.). The list is sent to Fernandez, the university instructor in Miami, and the fifth graders are informed by Palese that they will soon be receiving letters and a special assignment from university students who are studying to be teachers at St. Thomas University in Miami, Florida.

St. Thomas University is a private liberal arts institution with an enrollment of 3,000. The student population reflects the population of South Florida: a combination of different cultures, races, nationalities, and native languages. The undergraduate Education program, with 130 students, reflects the university student population. Studying to be teachers are native Nicaraguans, Colombians, Cubans, Haitians, and Mexicans; there are students from the Bahamas and other English-speaking islands; there are anglo-Americans and black-Americans. The students come from a variety of socio-economic levels. In a typical Education methods classroom one hears Haitian creole; Spanish spoken with the accents of several nationality groups; standard English; non-standard English; New England English; New York City English, etc.

One of the Education methods courses required of Education majors is EDU 306 Teaching Reading in the Elementary School. At the beginning of the fall term, on the first day of class, students in EDU 306 are informed that one of the course requirements is to assume the role of a teacher and create a reading lesson for a fifth grader in Wisconsin. The lesson is to be designed based on the needs and interests of the student. These needs and interests will be determined by the student's regular teacher in Wisconsin and by you, the Miami teacher, after you learn something about the student through an exchange of friendly letters and videotapes. The Miami teachers are then given copies of the Wisconsin class list that was sent to Fernandez by Palese.

The names that appear on the Wisconsin class list are different from the names on class lists in South Florida schools; this curious fact is used to introduce the Miami-

Wisconsin Project to the Miami teachers. A general discussion takes place on the spelling and likely pronunciation of student names, possible ethnic group affiliations, etc. After this class discussion, the names on the Wisconsin roster are randomly selected and a new, master list is printed, one that shows each Miami teacher with his or her Wisconsin student. The teachers then write a friendly letter of introduction to their students. A camcorder is brought into the classroom and each teacher gives a friendly greeting to the student; the teachers are videotaped in the order that their student's name appears on the master class list. The teachers then preview the videotape and critique their television performances. Afterward, the friendly letters, the master class list (now showing the names of the paired teachers and students), and the videotape are packaged and mailed to Palese's class in Germantown. The package arrives approximately one week later, and Palese distributes the letters and copies of the master class list to the students. After the letters are read, the videotape is previewed by the students using the master list to anticipate the order of appearance of their teacher. The students then respond by writing friendly letters, using the techniques of "friendly letter writing" that Palese has been explaining in class as part of the Lnaguage Arts curriculum. Each student, in addition, speaks directly to his or her teacher on videotape. This videotape is then previewed and critiqued by the students. The friendly letters and the videotape are then packaged and shipped to Miami.

> [While the friendly letters and videotape are being produced by the students in Wisconsin, the Miami teachers discuss the theoretical aspects of the Project, such as: the value of integrating different communications skills to promote literacy; student motivation; the uses of technology in teaching; lesson plan design, etc. These concepts are explored at the beginning of the EDU 306 Reading course so that the Education majors may have a theoretical foundation to their work in the Project. Eventually, other elements of reading instruction will be discussed during the semester, such as word recognition skills, standardized testing, etc.]

When the Wisconsin package arrives in Miami, Fernandez distributes the letters to each teacher and the videotape is previewed by the class. A general discussion then takes place on lessons that could be designed for given students. Several factors are considered in this discussion: the information offered by the students in their friendly letters (e.g., hobbies, interests, school likes and dislikes, family, etc.); requests from the students on specific assignments that they would enjoy; information or special characteristics given by Palese on special students; general information on the Rockfield School curriculum (e.g., classroom resources, library resources, subjects taught by Palese, class time allotted to each student to work on the lesson, etc.). Also considered is the writing and speaking ability of the students, as demonstrated by their friendly letters and televised statements. Throughout these discussions, the underlying goal of the Project is emphasized: to design a lesson that motivates the student to use all language arts communications skills.

The teachers then work individually on their lesson design for approximately two weeks; ideas are exchanged freely in class as the work progresses. The lesson must include clear instructions to students on what they must do and suggestions on how to obtain information; the class time that will be given them to work on the assignment by Mr.Palese is emphasized. A friendly cover letter accompanies the lesson. When completed, the friendly letter and the lesson are placed in an envelope addressed to the student, and the teacher meets privately with Fernandez to discuss the lesson design; final changes are made at this time if required. All of the lessons are then prepared for shipment in one, two, and sometimes three cardboard boxes. The teachers then make a new videotape, giving them an opportunity to clarify issues on their particular lesson, or to merely say hello to their students and wish them good luck. After this tape is critiqued by the class, the boxes and videotape are shipped to Wisconsin, where the students will begin work on their lessons approximately one week after shipment.

The fifth grade teacher in Wisconsin is not officially included in the lessons; each student is instructed to work independently. Palese, however, monitors classwork and helps students individually when appropriate. The assignments are completed in approximately two weeks; they are collected by Palese, and the students are videotaped again. Some students use this TV time to enhance their completed written lessons (e.g., science demonstrations, skits, live interviews, etc.); other students merely say hello to their teacher. The videotape is then previewed and critiqued by the students. All of the completed assignments (and the videotape) are then boxed and shipped to the teachers back in Miami.

By now it is the end of November and the teachers have until mid-December to complete their evaluations. During these two or three weeks, the university instructor will hold individual conferences with teachers and will use given lessons for general class discussion. Teachers determine their own evaluation techniques ("Should I give a letter or a number grade?" "How much should I count off for spelling and grammar?" "My student did not do my assignment! Instead, he designed his own research project...which is very impressive. Still, he did not do the work assigned. What grade should he get?"). In addition to this "formal" evaluation, all teachers write one final, friendly letter that includes a written opinion of the student's work. After the assignments are evaluated and are ready for shipment, the university instructor has one final, individual conference with each teacher for closure on the Project: the lesson design, the Wisconsin student's effort, and the teacher's evaluation of the student's work are all considered. The teacher then receives a letter grade from the university instructor on the assignment. The teachers appear one last time on videotape and offer closing remarks to the students on their efforts, then say good-bye. The graded assignments and videotape are then shipped to Wisconsin so that they will arrive in Germantown before the December holidays.

The Miami teachers usually send each child a small gift with the graded projects; this gift is not to exceed five dollars in value. The semester ends at St. Thomas University, and the EDU 306 class disbands. But after the New Year, in mid-January when the second semester begins, a new group of teachers enrolled in a new section of EDU 306 is informed of the long-distance project that they will work on and complete before the end of the term in May. (The Wisconsin students are informed of this new group of Miami teachers just before their classes end in December).

Critique of the Miami-Wisconsin Project

The Project is highly motivational for both the fifth graders in Wisconsin and the Education majors Miami. The university students have an opportunity to design a real lesson for a real elementary student (some Education majors have stated that the Project gave them their first exposure to teaching in the real world). University students enjoy the relationship established by writing friendly letters; they experience, in addition, another educational environment, in a different part of the country, with students that they would not normally teach. The educational value to the university students includes: 1) learning to create a lesson plan and implementing the plan; 2) evaluating the work completed by the student; 3) being evaluated by the university instructor on the over-all design (and success) of the lesson; 4) understanding the value of technology in education; 5) understanding the inter-relationship of all modes of communication for promoting literacy; and, 6) participating in the evaluations of their video presentations (including self-evaluation, peer-evaluation, and instructor evaluation).

The Wisconsin students enjoy establishing a long-distance relationship, through writing and videotape, with a new friend; and they are pleased when the new friend, a Miami teacher, gives them an opportuinity to choose the topic of their assignment. The educational value to the elementary students includes: using videotape to see and hear themselves; seeing and hearing on television individuals who may be culturally different, from a distant geographical area, but who wish to establish a friendly relationship; exercising research skills; participating in peer group activities with their classmates; and, participating in individualized instruction with their Miami teacher (self-esteem is fostered by this one-to-one relationship). The Project is valuable to Palese, who often combines the assignments with other subjects within his fifth-grade curriculum. And parents have often praised the Project and their child's involvement with it during parent-teacher conferences.

Limitations of the Project

1) The Wisconsin elementary students meet every day of the week for seven hours each day, whereas the Miami teachers meet only twice per week for a total of four hours; this results in a time delay in Miami. The students, already restless by nature, often complain: "It takes so long for the assignments to get here!" "Did the assignments get here yet, Mr. Palese?"
2) The Project is only one assignment in the EDU 306 Teaching Reading methods course, and must share class time with other course goals and objectives, such as Word Recognition Skills, Standardized Testing, Theories of Reading Instruction, etc. The Education majors and the university instructor, therefore, would enjoy added time on the Project.
3) The videotapes are interesting and effective, but much more can be done. In the present videotape procedure, both teachers and students speak to each other in one video sequence; each group previews a sequence taped by the other group. Each video sequence (approximately 20 minutes) is composed of short (15-30 seconds) segments, one linked to the next, with little opportunity for any one individual student or teacher to calmly and privately observe the speaker on the screen. With adequate time and resources, each student/teacher pair would use an individual VHS cassette tape.
4) There is a wide range of skills and abilities among the Education majors, and this is reflected in the variety and quality of the lessons. Some Wisconsin students, therefore, might receive an excellent assignment, whereas other students may not. Curiously, the Miami teachers, in an intellectual or figurative sense, seem to be mirror images of the Wisconsin students.

Future Trends

The Project will soon include new equipment that will allow the students and teachers to communicate in real-time: 1) audibly, by using the telephone; and, 2) in print, using computer terminals with modems and faxes. In addition, the Project might join one of the global computer networks, such as GTE Wolrd Classroom, and follow the Roanoke, Virginia middle school model in which the school was linked via computer with teachers and students in Texas, California, Argentina, and Mexico (Kurshan & Dawson, 1992). And with adequate funds, the Project could incorporate an up-link satellite system and establish live video communication between Rockfield students and St. Thomas teachers. The estimated cost of this communications link is over $150,000.00, and it is highly unlikely that the live link will be made.

Closing Comment

This report has explained the various components and procedures of the Miami-Wisconsin Project, a rich educational experience for students, teachers, administrators, and parents. Written language, however, may not give a clear picture of what happens because "...each art medium is a unique language capable of making statements that it would be impossible to articulate as effectively through any other medium." (Snider, 1960). One has to be present, for example, at the opening of the friendly letters to fully appreciate the magic that occurs.

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Simi Star Project: A Qualitative Study of Computers Integrated in Early Literacy Classrooms

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In 1990, six school districts, Simi Valley, Ventura, Santa Barbara, Orcutt, Oxnard, Port Hueneme joined together in a partnership with IBM. The Simi Star Project was a successful grant proposal written by Mary Beth Wolford representing the Simi Valley Unified School District. The project was the first of its kind in evaluation of computer technology in the schools.

Goals of the Project

The first goal of this large scale project was to demonstrate the use of Writing to Read (WTR) in support of a literature-based, whole language, writing process environment. Both kindergarten and first grade classrooms would be included. The project involved all students in the classrooms-including ESL, Bilingual, Special Education and Gifted and Talented. Writing to Read is a language arts computer-based program designed to foster literacy development (writing and reading) of young children. The computer is used to both individualize instruction so that children can work at their own pace and also create a new classroom milieu including computers for cooperative group, writing collaboration among students. According to Cynthia Greenleaf (1992), "Computers do not function as independent variables in classrooms, but rather as part of a complex network of social and pedagogical interactions."

The second goal was to enhance teacher productivity and competence. A comprehensive teacher training model and telecommunications network was developed. Teachers attended multiple workshops and then received onsite support and telecommunications coaching during implementation.

The third goal addressed a serious physical plant problem facing many school districts—lack of space. By placing the technology equipment directly into the classrooms, the need for separate space for computer labs was eliminated. Networking the classroom computers provides freedom from disk swapping and access that allows young children to independently log on and use computers throughout the school day.

Research Purpose -The Simi Star Evaluation Project

The primary emphasis of the project was to compare Writing to Read (WTR) in the classroom with WTR in both labs and settings without computers in the classroom. The research was designed to address these questions:

- Does integrating technology into the classroom become a natural extension of the teaching methodology and a familiar, non-threatening tool available throughout the school day to students?
- Is the equity of technology use for all students an important issue for the schools?
- How can a qualitative evaluation approach give us better data on the effect of computers integrated in the classroom on students writing and reading progress?

The issue addressed in this study was not whether computers can be used effectively—but how? This study attempted to show how teachers can best take advantage of the power and flexibility of computers to enhance student learning in their classrooms. The principal investigator was Dr. Jean M. Casey, Associate Professor of Reading/Language Arts, California State University, Long Beach. Others involved in the study were Ellen Lee, Asst. Supt. of Curriculum Simi Valley School District, Sherrie Kolz, IBM Education Instructional Specialist, six principals and 36 teachers and coordinators in the school districts.

In order to determine the effectiveness of the WTR program in developing literacy skills of kindergarten and first grade students, a two-group experimental design was employed. To insure a valid comparison of the effects of the WTR program with current instructional practices, both the experimental and control groups were selected from the same school districts.

Instruments for evaluation included observations in the classroom, pre and post reading attitude surveys, year long portfolios of writing samples, teacher questionnaires, parent questionnaires, administrator interview and questionnaire, student interviews, teacher and administrator journals. Results from interviews, questionnaires and journal reports were presented in percentages. 1000 writing samples were scored using a holistic rubric scale. In addition to the above, qualitative data was compiled in anecdotal record form.

Results of the Study

Conclusion 1: The most successful results occurred in school sites where the desire for the integration of technology in the classroom originated with the classroom teachers and where the site administrator shared the interest and desire to participate in this program. The elements of teacher and administrator expectation, enthusiasm and interest and support for a program are vital elements in the success of any school innovation.

Conclusion 2: All students in the experimental Writing to Read in the Classroom program averaged at least two writing levels higher then those in the control classrooms, the experimental group had a significantly higher positive reading attitude than the control group. Over 1,000 writing portfolios were collected from K-1-2 students representing 29 classrooms in 6 school districts. Included in the population were several Spanish language classrooms, ESL classrooms and classrooms with Learning Handicapped students. Also included were those identified ESL, LD, ADD, and gifted. These students achieved the same benefits from the program as did other students. Equity of technology use was provided for all.

Reactions of Program Participants

Parents in the WTR experimental classrooms enthusiastically endorsed the program. In the control groups over 50% of parents had no idea what program of reading or writing was being used in the classroom. Parents in the WTR samples reported significantly higher evidence of writing and reading behaviors their child demonstrated at home than parents in the control group. Twice as many students in the WTR program wrote stories at home and three times as many WTR students wrote notes at home, so both observable reading and writing behavior were significantly enhanced.

Experimental classrooms with ADD children reported that these children participated in a high level writing due the the ease of use of computer as opposed to the struggle of using a pencil, and had a positive attention span during their time on the computer. Computer use seems to be a highly successful intervention for these students as with dyslexic and other learning disorders. Further research needs to be conducted specifically on the effect of computers for empowering these learners.

The Spanish experimental classrooms had many striking examples students empowered by computer use. One fourth grade non-English speaker from Mexico learned English well enough in six months to become the computer monitor in his fourth grade class. The principal reported that this boy turned from a high risk student to a leader in the fourth grade due to his involvement with the program.

Teachers reported they felt that this program improved the students writing and reading significantly and reported they had now made computers an integral part of their classroom. One teacher summed up all of their feelings perfectly when she said, "How terrible it would be to be forced to go back to teaching without computers!"

"What did principals think of this program?" Principals reported 75%-100% integration of computers in all K-1 classrooms. They felt the most positive results were for their students and their teachers in providing a risk-free environment for learning within classrooms.

In summary, boys and girls in the Writing to Read in the classroom experimental groups were writing at higher levels than the boys and girls in the WTR lab or control groups. However the WTR lab students wrote at higher levels than the traditional classroom control group.

"Even though this is my first child in school, I know she is ahead in reading and writing ability due to this outstanding program! In kindergarten she came home and read to me, I had no idea she could read, and it's just progressed from there—the sky's the limit and she's able to express in writing whatever she feels! We feel very privileged to have had the opportunity to be in the WTR program!" Kindergarten Parent Nightengale School.

Financial Support

Computer labs donated by The Riordan Foundation
Los Angeles, California
Evaluation report funded by IBM Partnership Grant

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TELECOMMUNICATIONS 1

Section Editors:
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Frank Becker

Last year the explosive growth of the Internet was perhaps the most significant trend in telecommunications. The number of servers on the world's largest telecomputing network exceeded a million, and at last report the Internet was growing at a rate of approximately a thousand servers per day. Since the number of users supported by each server may range from dozens to thousands, the total number of individuals who now have access to the Internet can only be estimated.

Two trends are notable this year: the rapid development of graphical interfaces for Internet access, and the parallel growth of client-server Internet tools. The rapid spread of Internet gophers exemplifies this trend. Internet gophers were developed at the University of Minnesota, home of the "golden gophers." This client-server tool "goes for" information on an Internet server and retrieves it, so the name is a pun - an instance of Internet humor.

The Society for Technology and Teacher Education (STATE) Internet server was announced at the 1993 STATE conference in San Diego. The archiving mechanism for the STATE server was developed in 1992 before Internet gophers were ubiquitous. By Spring 1993 it was increasingly clear that Gophers would become the *de facto* standard for Internet archives. During the Summer 1993 the code for the STATE Teacher Education Server was revised to incorporate gopher technologies. Directions for accessing the National Teacher Education Internet Server established under the auspices of STATE are provided in the initial article in this section: "The Teacher Education Internet Server - A New Information Technology Resource."

Although Internet gophers are evolving rapidly, other graphical client-server tools are also maturing. The Mosaic interface is one of the more promising of these tools. Mosaic provides hypermedia links across the Internet. For example, clicking on the name *Al Gore* in a Mosaic document could cause an image of the vice president to appear on a computer screen linked to the Internet. A second click on a microphone icon beside the vice president's picture might produce a spoken welcome. The Mosaic client software on the user's computer transmits a request to an Internet server thousands of miles away to transfer the image and the digitized sound. Terabytes of information on Internet servers around the world can be accessed by K-12 computers in this manner. Completion of Mosaic client software for MS-Windows and Macintosh computers in 1993 has made this tool considerably more accessible.

Because of the bandwidth required by digitized images and sounds, Mosaic is most usable through a direct Internet connection. Most universities have such connections, but only a handful of schools have direct links to the Internet. In fact, the majority of K-12 schools are still struggling to identify ways to obtain phones lines which will provide dial-up connections to Internet hosts. A national debate regarding establishment of a National Information Infrastructure (NII) during the past year raises questions of equity, and how best to extend the national information highway to all schools. The Consortium for School Networking (COSN) has been in the forefront of efforts to ensure that K-12 schools will be included in the emerging national network.

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Information about COSN can be obtained through the COSN Internet gopher: "cosn.gopher.org". (The STATE Teacher Education Server also provides links to the COSN gopher.)

Teacher education programs have an obligation to provide preservice teachers with information about future technologies as well as ones which are currently found in K-12 schools. The career of the average teacher graduating from today's teacher education programs will extend well into the next century when technologies now found primarily within universities will be commonplace in K-12 schools as well. Three papers address approaches, strategies, and benefits associated with use of educational telecomputing. Judi Harris' paper, "A Model for Integration of Telecomputing in Precollege Curricula" outlines strategies for meaningful incorporation of telecomputing tools into the curriculum. Harris' thesis is that the most successful teachers "re-invent" and adapt innovations to match their individual teaching styles and curricula. The corollary is that teacher education programs should not only demonstrate telecomputing tools, but should also illustrate the accompanying process of re-invention and innovation in successful K-12 classrooms. Nikki Davis' paper, "Identifying and Evaluating the Benefits of Educational Telecomputing," addresses an important related question - the value of educational telecomputing. Jan Stuhlmann's study focuses on a third aspect, factors affecting classroom use, in "Factors Affecting Incorporation of Telecommunications into Teaching Practices: Circumstances and Experiences Leading to Change."

A second trio of papers addresses specific uses of telecomputing in teacher education programs. Linda Hoover's paper, "Use of Telecomputing to Support Group-Oriented Inquiry during Student Teaching," describes the use of telecomputing to encourage reflective thinking during the student teaching process. Yan, Anderson, and Nelson mirror this theme in "Facilitating Reflective Thinking in Student Teachers through Electronic Mail." Harrington and Quinn-Leering describe explicit efforts to employ computer conferencing to encourage moral discourse. This use of telecomputing is described in " Computer Conferencing and Moral Discourse in Preservice Teacher Education."

Two final papers in this section describe ways in which telecomputing have been incorporated into teacher education programs. Espinoza and McKinzie describe use of the Internet and the Texas Education Network (TENET) at East Texas University and West Texas A&M University, in "Incorporating Use of the Internet in Teacher Education Courses." Stahlhut describes ways in which a computer conferencing system, CAUCUS, has been used to link inservice teachers with teacher education faculty in "Linking Practitioners and Teacher Education Faculty through a Computer Conferencing System."

Almost every university in the nation is now linked to the Internet, and access for faculty and students is either available at no charge or for a nominal fee at most institutions. As faculty gain expertise with the Internet it should become an integral element of teacher education programs. When this year's class of entering teacher education students graduates four years hence, they should be prepared to use the networking resources which are becoming increasingly available in the public schools.

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The Teacher Education Internet Server: A New Information Technology Resource

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University of Houston

Glen Bull
University of Virginia

Valerie Larsen
University of Virginia

Jason Mitchell
University of Virginia

In 1992, the Society for Technology and Teacher Education (STATE), the University of Virginia, and the University of Houston collaborated to establish a Teacher Education Server on the Internet. The Internet offers an expanding variety of electronic services for support of academic collaboration. These electronic services on the Internet allow users to find information such as lesson plans, interactive dialogs with content experts, and collaborative network projects.

The Teacher Education Internet Server was established to explore the ways in which the tremendous amount of information on the Internet could benefit teacher education programs. During the last year, work has progressed to provide a single network site where educators can go to access materials related to teacher education. The Teacher Education Internet Server is physically located at the University of Virginia on an IBM RS-6000 UNIX workstation donated by IBM. The Teacher Education Internet Server provides access to two of the most widely used network services, archived documents and interactive discussion groups.

Internet Gophers

A "gopher" is a menu driven tool for accessing information resources across the Internet. This tool was developed at the University of Minnesota (home of the "Golden Gophers") to provide a mechanism where network users could "go for" information or "tunnel through" the Internet. Documents stored on Internet gophers may contain text documents, graphics files, sound resources, and software applications. The Teacher Education Server's Gopher menu allows users to access a variety of resources relating to the field of teacher education, the Society for Technology and Teacher Education, and other educational resources on the Internet.

Interactive Discussion Groups

In contrast to Gophers, which are generally "read-only" tools, discussion groups provide one of the most widely-used avenues for interactive discussion on the Internet. Currently there are more than 2,000 discussion groups (or "newsgroups" as they are customarily called) on the Internet. A general newsgroup has been established as a forum for educators who want to participate in an interactive discussion about the use of technology related to teacher education. As participants begin to discuss topics in detail, additional newsgroups will be established on more specific topics such as math and science, hypermedia, research, or any topic of interest, related to teacher education. Input from postings to the general newsgroup will help shape the future direction of the resources available on the Teacher Education Internet Server.

The Interactive Resources section of the Teacher Education Internet Server also provides other interactive services, such as the ability to submit articles to Interface (the IBM Teacher Preparation Grant newsletter), interact with authors of Interface articles, and obtain a subscription to the newsletter.

The Teacher Education Internet Server provides access

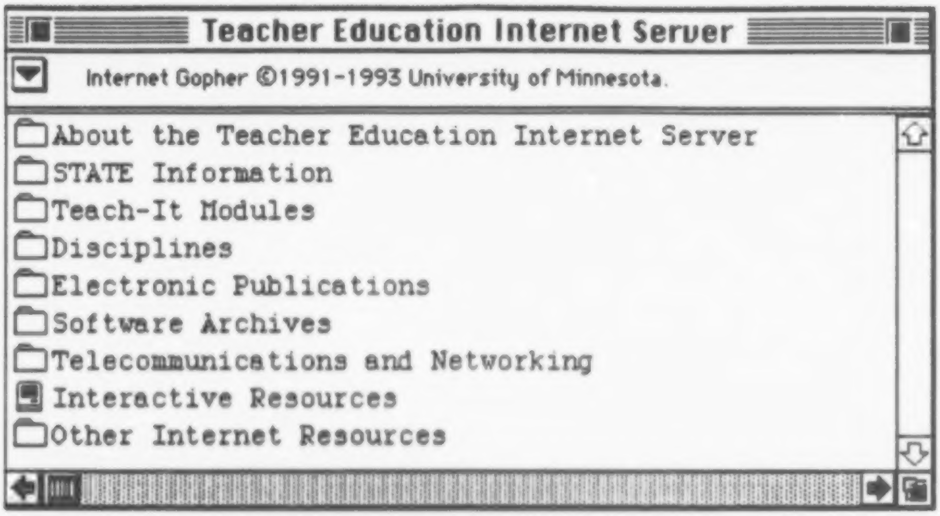

Teacher Education Internet Server
Internet Gopher ©1991-1993 University of Minnesota.
About the Teacher Education Internet Server
STATE Information
Teach-It Modules
Disciplines
Electronic Publications
Software Archives
Telecommunications and Networking
Interactive Resources
Other Internet Resources

Figure1. The Teacher Education Internet Server Gopher Menu as Seen with a Graphical Gopher Software Application.

to both gopher capabilities and interactive resources. Tim Sigmon, Director of Advanced Technology and Academic Projects at the University of Virginia, developed the software which underlies the server, using tools and concepts previously employed in the development of Virginia's statewide K-12 Internet network as well as gopher software. The Teacher Education Internet Server provides teacher education faculty and students access to information in the field of information technology and teacher education. The server was designed to facilitate the discussion of ways educational technologies may be integrated into the instructional process.

The Teacher Education Internet Server is a prototype system. Therefore, the menus will be changing to reflect the development of new and more useful resources. However, the general concepts outlined below will hold true, even though enhanced features may alter the menus. Resources currently available on the Teacher Education Internet Server include:

- Teach-It Modules — downloadable self-instructional modules on various subjects in instructional technology. The modules were developed for use in teacher education courses.
- Telecommunications and Networking Information — resources such as an overview of the Internet, frequently asked questions about telecomputing, bibliographic information, and articles on instructional uses of telecomputing.
- Electronic versions of the Society for Technology and Teacher Education Annual, Ed-Tech Review (the member magazine of the Association for the Advancement of Computing in Education (AACE), and Abstracts from the Journal of Technology and Teacher Education (JTATE).
- An online version of the Interface newsletter which will allow users to submit articles, interact with authors, and obtain a subscription.
- Software Archives – shareware and freeware software programs relevant to instruction, available in Macintosh and DOS formats.
- Links to other resources on the Internet – including FTP sites, other Gopher servers, and online library catalogs.

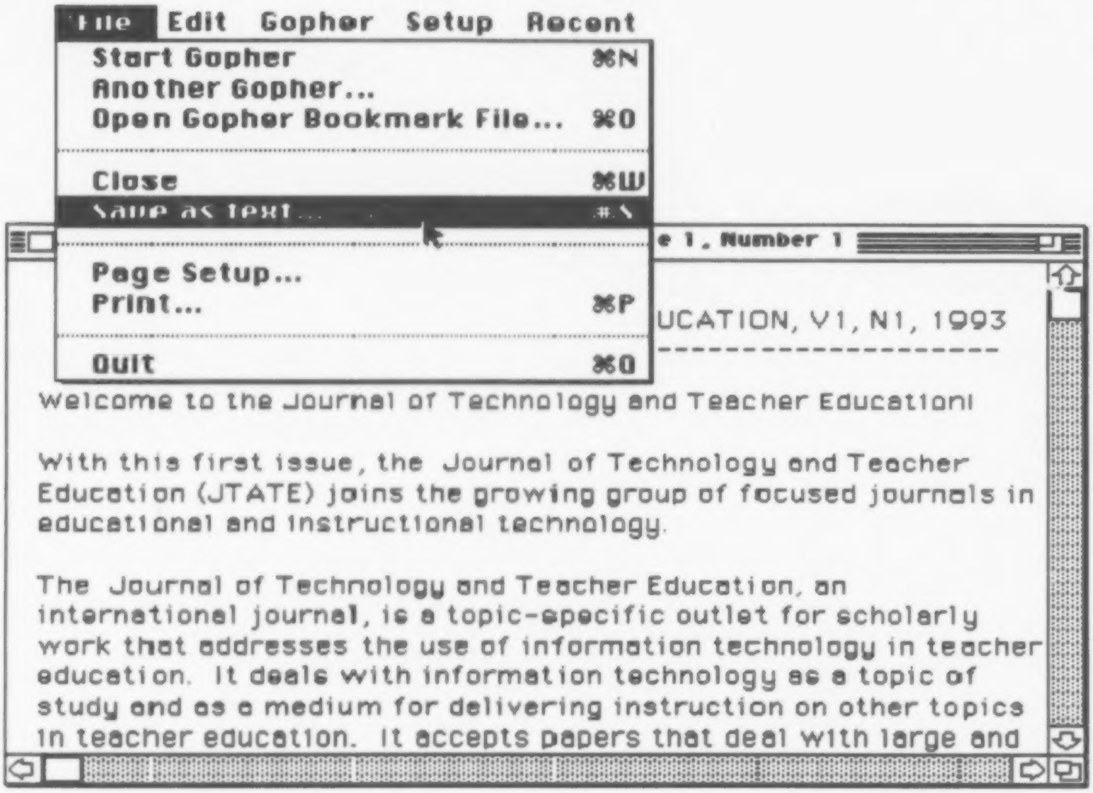
In addition, users can:

- Participate in online discussion groups
- Apply for STATE membership
- Use an electronic suggestion box to submit questions and comments about the Teacher Education Server.

The goal of the Teacher Education Internet Server is to lead the way in exploration of electronic resources elated to technology in the field of teacher education. Users are invited to log onto the system and explore the resources currently available. Other resources which are currently under development include materials related to specific content areas such as mathematics education, science education, language arts, social studies, elementary education, and special education.

Connecting to the Teacher Education Internet Server

The best way to access the Teacher Education Internet Server is through a gopher with a graphical interface, such as *PC Gopher* (for IBM) or *TurboGopher* (for Macintosh). These software programs establish a client-server relationship in which part of the gopher program (the client) resides on your machine while the other part of the gopher program (the server) resides on a system such as the Teacher Education Internet Server. Most university computing centers should be able to assist with installation and



UCATION, V1, N1, 1993

Welcome to the Journal of Technology and Teacher Education!

With this first issue, the Journal of Technology and Teacher Education (JTATE) joins the growing group of focused journals in educational and instructional technology.

The Journal of Technology and Teacher Education, an international journal, is a topic-specific outlet for scholarly work that addresses the use of information technology in teacher education. It deals with information technology as a topic of study and as a medium for delivering instruction on other topics in teacher education. It accepts papers that deal with large and

Figure 2. The "Save" Menu as Seen with a Graphical Gopher Software Application.

configuration of this software. To connect to the Teacher Education Internet Server, you only need to know the full Internet name of the Teacher Education Internet Server, which is:

teach.virginia.edu

Using Graphical Gopher Software to Connect to the Teacher Education Internet Server

Once you have connected to the Teacher Education Internet Server via PC Gopher or TurboGopher, you will see a list of folders which contain teacher education files and resources. The files in each folder are displayed when the user clicks on the folder. The graphical gopher menu is shown in Figure 1. The advantage of using graphical gopher software to connect to the Teacher Education Internet Server is that ease-of-use will be available. For example, rather than following a multistep downloading procedure to save a file, you will simply select "Save" on the menu just as you would in your word processing program. Figure 2 illustrates the "Save" menu for a Teacher Education Internet Server text file accessed through an Internet gopher with a graphical user interface.

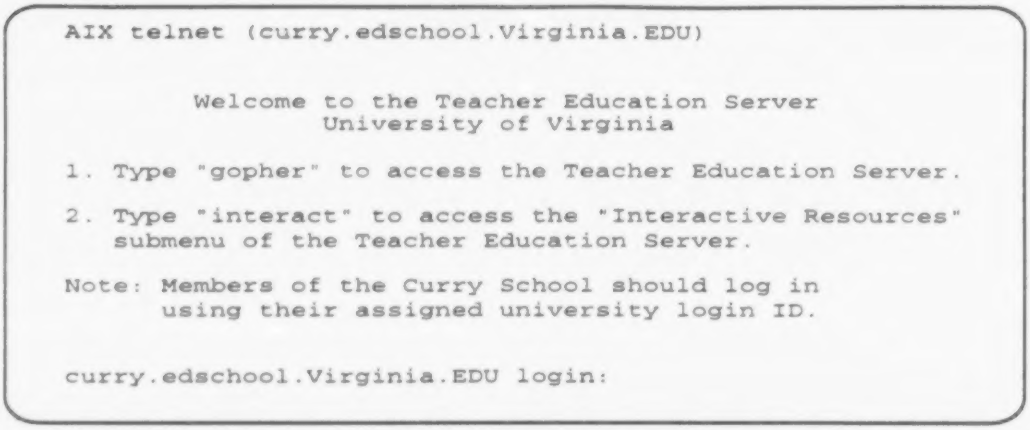
Gophers have swept the Internet during the last year, but if your campus computing center does not have experience with gophers, they can obtain free gopher client software from the University of Minnesota for installation at your school. For more information, you may contact the University of Minnesota's Computer and Information Services via e-mail at: gopher@boombox.micro.umn.edu

Connecting to the Teacher Education Internet Server via Telnet

It is possible to access the Teacher Education Internet Server, even if you do not yet have access to gopher software, by using the standard Internet telnet capability. This protocol, commonly found at most colleges and universities, allows computer users to connect to another computer system on the Internet. If you have not used telnet before, you may need to contact your school's academic computing center for assistance. To access the Teacher Education Internet Server through telnet at most universities, you will enter the following command through your campus network:

```
telnet teach.virginia.edu
```

Some computing centers have menus to facilitate telnet access by inexperienced users, so you may wish to contact your computing center for details on using telnet at your



```
AIX telnet (curry.edschool.Virginia.EDU)

        Welcome to the Teacher Education Server
                University of Virginia

1. Type "gopher" to access the Teacher Education Server.

2. Type "interact" to access the "Interactive Resources"
   submenu of the Teacher Education Server.

Note: Members of the Curry School should log in
      using their assigned university login ID.


curry.edschool.Virginia.EDU login:
```

Figure 3. The Welcome Screen for the Teacher Education Internet Server as Seen When Accessed via Telnet or a Text-Oriented Gopher Application.

university. When you are prompted for a login, type "gopher" and press <return>. You should then see:

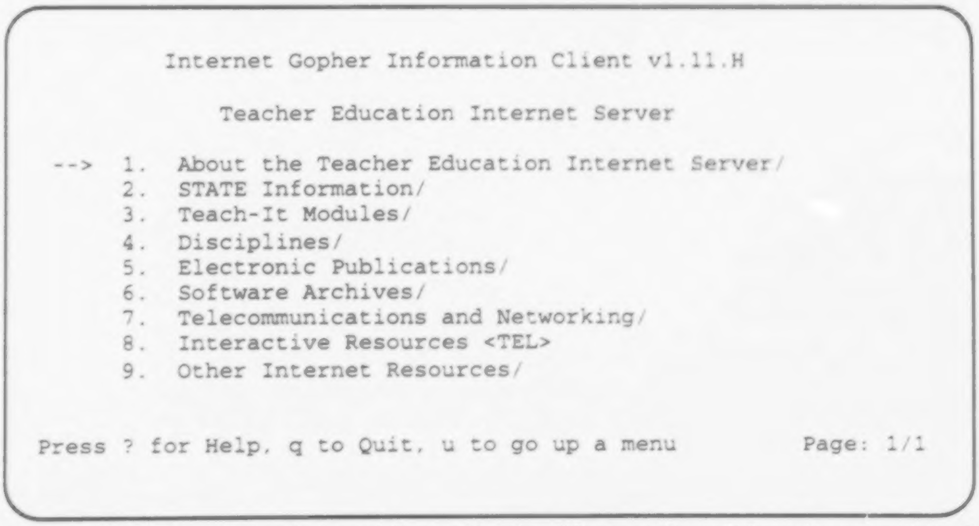
Enter terminal type (default is vt100):

In most cases, Telnet software will support vt100 terminal emulation. Simply press <return> to accept "vt100" as the default terminal emulation. (In the rare instance of telecommunications software which does not support vt100 emulation, enter "?" for a list of other supported terminal emulation types.) If you are using a text-oriented gopher or accessing the Teacher Education Internet Server through Telnet, you will see the welcome screen, as shown in Figure 3.

Once you are connected to the Teacher Education Internet Server either via Telnet or a text-oriented gopher, use your arrow keys to move the selection arrow "—>" to the menu item you wish to explore and press <return>. The text-oriented gopher menu is shown in Figure 4.

The Interactive Resources Menu

The Interactive Resources which are available on the Teacher Education Internet Server allow users to leave the gopher menu and view a different menu screen of discussion groups and other interactive resources, To access these interactive resources, choose the last item on the gopher menu, "Interactive Resources." Type "interact" and press <return> at the first login prompt. You will now be asked for your User ID. Before you can participate in the discussion groups or use the interactive resources of the Teacher Education Internet Server, you must create a User ID. If you have previously established an account on the Teacher



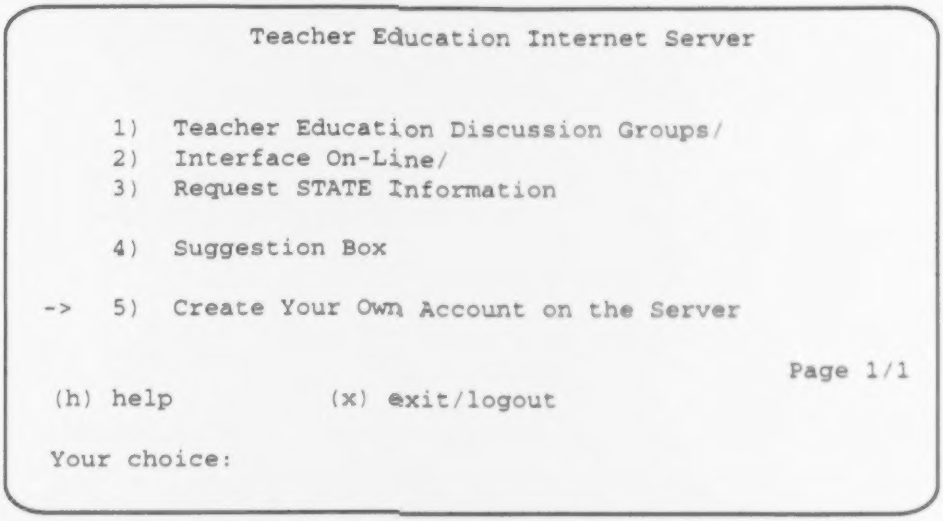
```
          Internet Gopher Information Client v1.11.H

             Teacher Education Internet Server

 -->  1.  About the Teacher Education Internet Server/
      2.  STATE Information/
      3.  Teach-It Modules/
      4.  Disciplines/
      5.  Electronic Publications/
      6.  Software Archives/
      7.  Telecommunications and Networking/
      8.  Interactive Resources <TEL>
      9.  Other Internet Resources/


Press ? for Help, q to Quit, u to go up a menu        Page: 1/1
```

Figure 4. The Teacher Education Internet Server Gopher Menu as Seen When Accessed via Telnet or a Text-Oriented Gopher Application.



```
                Teacher Education Internet Server


        1)   Teacher Education Discussion Groups/
        2)   Interface On-Line/
        3)   Request STATE Information

        4)   Suggestion Box

   ->   5)   Create Your Own Account on the Server

                                                        Page 1/1
   (h) help          (x) exit/logout

   Your choice:
```

Figure 5. The Interactive Resources Menu of the Teacher Education Internet Server.

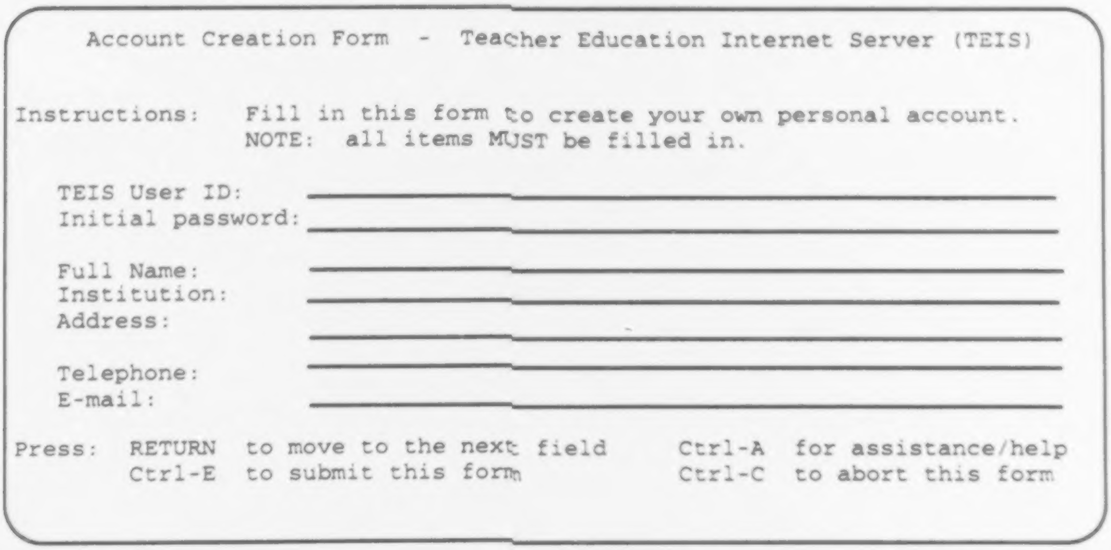
Education Internet Server, simply enter your User ID and password at the prompts. Your name and the electronic mail address which you gave when you established the User ID will now be added to your contributions to the Interactive Resources.

If you are a first-time user, type <return> at the User ID prompt and select the last menu item, "Create Your Own Account on the Server," as shown in Figure 5.

You will be given an online form to fill out. The form, shown in Figure 6, will require you to enter some information about yourself and what you would like your User ID and password to be.

Future Plans for the Teacher Education Internet Server

Since the Teacher Education Internet Server is a developing system, many additional resources are planned but have not yet been implemented. New content area resources are currently being developed for mathematics education and language arts and will be added to the "Disciplines" section. Also planned is an area on research which will include articles and dissertation materials related to technology and teacher education. New newsgroups are also being developed which will address specific issues of interest to teacher educators, preservice teachers, and the K-12 community.



```
    Account Creation Form  -  Teacher Education Internet Server (TEIS)

Instructions:   Fill in this form to create your own personal account.
                NOTE:  all items MUST be filled in.

   TEIS User ID:     ____________________________________
   Initial password: ____________________________________

   Full Name:        ____________________________________
   Institution:      ____________________________________
   Address:          ____________________________________
                     ____________________________________
   Telephone:        ____________________________________
   E-mail:           ____________________________________

Press:  RETURN  to move to the next field     Ctrl-A  for assistance/help
        Ctrl-E  to submit this form           Ctrl-C  to abort this form
```

Figure 6. The Teacher Education Internet Server Account Creation Form.

If You Need Help with the Teacher Education Internet Server

The Teacher Education Internet Server has many help files to guide you as you navigate through the system. At the beginning of many options, you will see help files entitled "About ...." For example, the "About STATE Teach-IT Modules" file describes what Teach-It modules are and how they may be used.

If you questions about using the Teacher Education Internet Server, you may contact the curator of the Server in two ways. The first is to use the electronic suggestion box located under the menu item, "Interactive Resources." The suggestion box allows you to ask questions or seek further information about the system. Or you may send an e-mail message directly to the curator of the Teacher Education Internet Server. The current curator is:

Bernard Robin
University of Houston
phone: (713) 743-4952
e-mail: brobin@uh.edu

The Teacher Education Internet Server is envisioned as a tool which will be useful for anyone interested in teacher education. The success of this tool will depend upon faculty members, students, and other educators who log onto the system and not only utilize the available resources, but also share their thoughts and ideas with their colleagues.

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A Model for Integration of Telecomputing in Precollege Curricula

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Successful technology-using teachers function more as instructional designers than lesson planners. This is especially true when they seek to incorporate the use of forward-thinking, computer-mediated innovations, such as telecomputing tools, into existing curricula. New tools require new techniques, incorporated into new models of teaching and learning processes, if the tools' most powerful attributes (Clark, 1983) are to be exploited. When attempting to encourage meaningful curricular infusion of telecommunications into precollege curricula, teacher educators therefore must pay careful attention to key ideas both in the diffusion of innovations and in the education of instructional designers.

The Diffusion of Interactive Communications Innovations

Everett Rogers (1986) has qualified his well-known work on the diffusion of innovations to address the special nature of the diffusion process that occurs when communications innovations are adopted. Meta-analytic synthesis of communications studies results revealed three ways in which the adoption of interactive communications innovations differs from similar processes with other innovation types.

1. A *critical mass* of adopters must be using the innovation to persuade potential adopters to do the same; "the usefulness of a new communication system increases for all adopters with each additional adopter" (p.120).
2. The *degree of use* of a communications innovation, rather than the decision to adopt it, is the dependent variable that will indicate the success of the diffusion effort.
3. New communication technologies are *tools,* which can be applied in many different ways and for different purposes. Therefore, adoption of these innovations is an active process that involves much *re-invention,* or "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 1983, pp. 16-17).

It is the importance of re-invention that must not be overlooked by the teacher educator seeking to ensure the meaningful integration of telecomputing tools into precollege curricula. Innovations that are more flexible, with many possible applications (like telecommunications innovations), and those that are shared via a decentralized diffusion network (like telecomputing tools), are more likely to be re-invented than those that are less flexible or are diffused according to a centralized plan (Rogers, 1986). Also, re-invention appears to be very important psychologically to adopters of such innovations (Rogers, 1983); adopters must take the innovation and "make it their own" if use of the innovation is to continue. When helping teachers to learn to use telecomputing tools, teacher educators must anticipate, stimulate, and encourage teachers' re-inventions of curricularly-based telecomputing applications. Sadly, this is not what usually occurs.

The Telecomputing Teacher as Instructional Designer

Most teachers, working alone in a classroom, are both the designers and the deliverers of instruction (Briggs, 1977). This implies that teachers are expected to design learning activities for their students on an ongoing basis, selecting, adapting, and using instructional materials and activities according to the learning needs and styles of each unique group of students. The extent to which this design process is effective determines, in part, students' eventual learning success.

When new teaching/learning tools are presented to teachers for possible adoption, what happens? Once the initial technical and procedural aspects of use are presented (preferably through hands-on experience), curricular integration is addressed. This sequence is appropriate, because powerful educational applications of new technological tools with unique media attributes (Clark, 1983) cannot be conceived until potential adopters are aware of the full range of those attributes (Rogers, 1983).

But what happens then? In many cases, the now-technically-facile teacher is presented with a plethora of application ideas, often in the form of lesson plans or project reports, usually separated by content area and/or grade level. (See, for example, Roberts, Blakeslee, Brown & Lenk's (1990) rich, but difficult-to-use collection of educational telecomputing applications, pp. 81-138.) Educators are then asked to choose from many different activities that were created to fit the needs and preferences of groups of students different from their own, and adapt these activities for use in their own classrooms. With no guidance in the *design* of powerful innovation applications, it is no wonder that so few initial curricular integration attempts exploit the unique characteristics of educational innovations, and so many applications seem similar to those that were implemented with more traditional media (e.g., the early proliferation of one-to-one penpal letters sent via electronic mail (Riel & Levin, 1990)).

To ensure the adoption and maximally powerful, continued use of educational innovations, teachers (and students) must have opportunities to re-invent educational applications as instructional designers. But since the unique attributes of the new tools imply that specialized applications must emerge if powerful use is to be made of the innovations, instructional design cannot be modeled solely upon the structures of educational activities that employ more traditional media. New *models* for activity design must be provided for all but the most creative and innovative educators, if new tools are to be used in new ways.

Instructional Design: A Models Approach

The work of Joyce and Weil (1972; 1986) and their advocates (e.g., Gunther, Estes & Schwab, 1990) suggests that teachers' planning for instruction is greatly facilitated by their taking a *models approach* to instructional design. With this approach, teachers choose from a variety of procedures (e.g., direct instruction, synectics, inquiry, class discussion, or cooperative learning) the model that, given the learning needs and preferences of a particular group of students, will best help the students to accomplish specified educational goals. An important assumption of this approach is that there is no one "best" model for any student, teacher, or group. Rather, a variety of models; a "cafeteria of alternatives" (Joyce & Weil, 1972, p. xiv), carefully selected and consciously applied, will help to create optimal learning environments for students.

Much of what has been published about using models for instructional design addresses selection in terms of type of teacher-student and student-student interaction, and asks the teacher to design specific learning activities that are appropriate in the selected classroom environment. While this level of guidance may be sufficient for teachers who are using instructional media familiar to them, it probably is insufficient for the teacher who seeks to infuse powerful use of new educational innovations with unique media attributes. Models for the design of forward-thinking, cross-curricular, multi-level *activities* must also be provided if educational innovations, such as telecomputing tools, are to be used meaningfully in precollege curricula. Strain (1986) characterizes this distinction in level at which model application occurs as the difference between a general "curriculum plan" and a specific "instructional procedure" (p. 287).

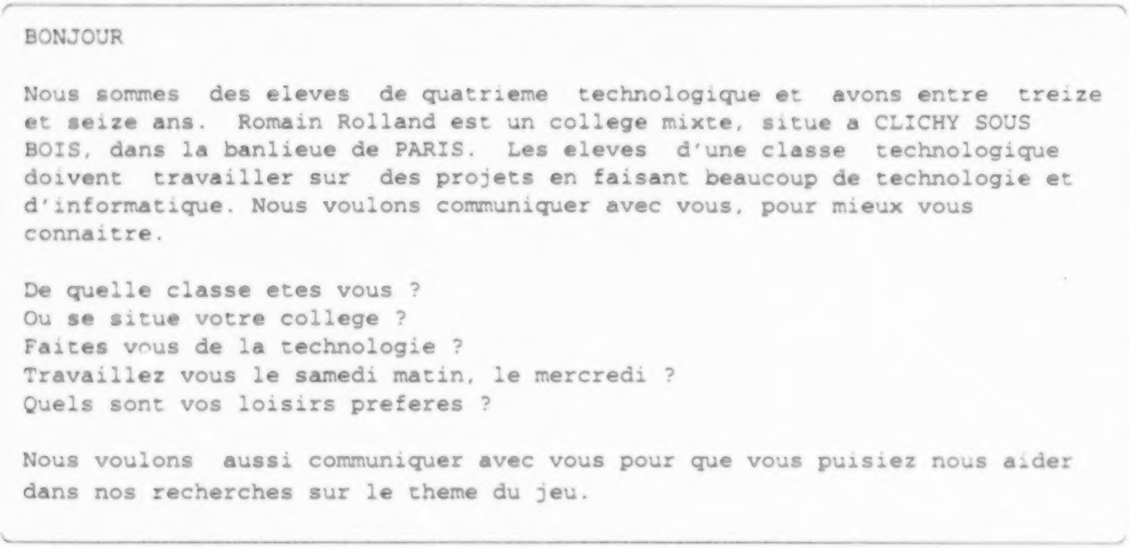
The use of models in the instructional design of educational activities, rather than the replication/adaptation of existing lesson plans and activity ideas, allows for the large amount of re-invention necessary to make long-term innovation adoption probable in precollege classrooms. The more an educational innovation is unlike a previously-employed tool, the more important it probably is to provide models of specific instructional procedures, or *activity structures,* to potential innovation adopters. The remainder of this paper will suggest a collection of 16 such activity structures, organized into three genres of student activity, that can be used to assist teachers, functioning as instructional designers, in the re-invention (and therefore successful adoption) of educational telecomputing tools.

Telecomputing Activity Structures

In an informal content analysis of hundreds of educational telecomputing activities that were shared by teacher-designers via the Internet, three genres of student action, each including 5 or 6 activity types, emerged. The genres of student action were labeled according to the dominant types of learning acts that each class of activity structure encompassed: *interpersonal exchanges, information collections,* and *problem-solving projects.*

Interpersonal Exchanges

The most popular type of educational telecomputing activity is one in which individuals "talk" electronically to other individuals, individuals "talk" to groups, or groups "talk" to other groups. Many of these project types employ electronic mail as the common context for exchange. Others use newsgroups and Internet-connected bulletin


BONJOUR

Nous sommes des eleves de quatrieme technologique et avons entre treize et seize ans. Romain Rolland est un college mixte, situe a CLICHY SOUS BOIS, dans la banlieue de PARIS. Les eleves d'une classe technologique doivent travailler sur des projets en faisant beaucoup de technologie et d'informatique. Nous voulons communiquer avec vous, pour mieux vous connaitre.

De quelle classe etes vous ?
Ou se situe votre college ?
Faites vous de la technologie ?
Travaillez vous le samedi matin, le mercredi ?
Quels sont vos loisirs preferes ?

Nous voulons aussi communiquer avec vous pour que vous puisiez nous aider dans nos recherches sur le theme du jeu.

Figure 1. Introductory Electronic Mail Message from French Students.

boards for exchange.

Keypals

This is probably the most commonly-used telecomputing activity structure, similar in form to surface mail penpal activities. While student-to-student *keypal* exchanges involve more managerial work than many teachers have time to devote, group-to-group exchanges, especially those with a particular study emphasis, can evolve into fascinating cultural explorations without overwhelming activity facilitators with the transfer and processing of electronic mail.

Keypal activities are perfect conduits for language study. Figure 1, for example, shows the introductory message from a group of students who live near Paris, and wished to learn about classes from other parts of the world in which other students study computer use.

Global Classrooms

In this variation upon the "group-to-group keypals" activity structure, two or more classrooms (located anywhere in the world) can study a common topic together, sharing what they are learning about that topic during a previously-specified time period. For example, two American Literature classes in two different schools studied *The Glass Menagerie* together in 1991, discussing the play by electronic mail.

In a larger-scale effort to involve many classes in HIV/AIDS awareness, Rhea Smith from the Jenkins Middle School in Palatka, Florida, organized a month-long series of activities designed so that her students "help[ed] teachers, parents, and children to understand the dangers of the HIV/AIDS virus and formulate a plan to remain HIV/AIDS negative." Suggestions for discussion and action for each week of activities was included in the plan.

Electronic Appearances

Electronic mail, newsgroups and electronic bulletin boards can also "host" a special guest, with whom students can correspond either asynchronously or in "real-time," with the guest and the students typing back and forth to each other synchronously, using a *chat feature* that is available with many electronic mail systems.

One such "electronic event" was held in *Academy One* on the National Public Telecomputing Network's *Cleveland Freenet* this past fall. Nobel Laureate Paul Berg had a "virtual visit" with high school students from many different states, provinces and countries. Dr. Berg electronically supplied a paper that he had written on gene splicing and a *.gif* encoded picture of himself that students could use to help them to prepare questions for the electronic meeting.

Electronic Mentoring

Internet-connected subject matter specialists from universities, business, government, or other schools can serve as electronic mentors to students wanting to explore specific topics of study in an interactive format. Undergraduate students at the Oranim Teacher's College in Israel, for example, served as mentors on the subject of *prejudice* when communicating with high school students for two academic semesters from England, Australia, the United States, Ireland, and Israel. A "matching service" called the *Electronic Emissary*, sponsored by the Texas Center for Educational Technology and the University of Texas at Austin, helps volunteer subject matter experts from all over the world find teachers and their classes, structure a mentoring project, and share what they learn together by communicating with electronic mail.

Impersonations

Impersonation projects are those in which participants communicate with each other "in character." In several of the electronic pavilions on Virginia's PEN, for example, students correspond with professors or graduate students posing as well-known historical figures, such as Thomas Jefferson, Woodrow Wilson, or William Shakespeare. In *Characters Online*, an Internet-based project sponsored by the Nebraska State Department of Education and the University of Nebraska at Omaha, undergraduate preservice teachers used electronic mail to impersonate the main characters from books that students in elementary classes in eastern Nebraska were reading with their teachers.

Students can also write messages or public postings in character for other students to read. In the *California Missions* project, coordinated by Nancy Sutherland from the FrEdMail Network, 21 fourth grade classes in California (one for each of the 21 California missions) wrote and shared fictitious journal entries that described the lives and aspirations of people who participated in the missions in the early and middle 19th century.

Information Collections

Some of the most successful educational telecomputing activities involve students collecting, compiling, and comparing different types of interesting information.

Information Exchanges

There are many examples of thematically-related information exchange that have been employed as popular telecomputing activities. Students and their teachers from all around the globe have collected:

- folk games,
- jokes,
- proverbs,
- folktales,
- local agricultural information,
- biome data,
- water usage information,
- recycling practices,
- personal health information,
- and culture-specific holiday descriptions, to name just a few.

This type of activity can involve many classes without becoming an overwhelming management task for teachers, and is a particularly powerful application of telecomputing tools because children become both the creators and consumers of the intrinsically interesting information that they are exchanging.

Electronic Publishing

Another type of information collection and exchange can occur with electronic publishing of a common document, such as a newspaper, poem, or literary magazine. In The Global Schoolhouse Project's yearly *Newsday* project, participating teachers and students publish different newspapers locally, but take many of the stories for those local publications from a "newswire" shared electronically among all participating sites. The stories posted to this newswire are, of course, researched and written by students from all of the participating classes. In this way, students from participating schools in different cities, states, and countries experience an operationally realistic simulation of how many local newspapers are created and published.

Database Creation

Some information exchange projects involve not only collecting, but also organizing information into databases that project participants and other students can use for study. One such project is a statewide collaborative exploration of Texas history (1830-1900) in which the documents that result from students' site-based research were added to an Internet-accessible Gopher, and then used in further research and synthesis by more students.

Tele-Fieldtrips

Organizers for the Global Schoolhouse Project encourage Internet-connected teachers and students to share observations and experiences made during local fieldtrips to museums, historical sites, parks, zoos, etc. with teachers and students from other cities, states, and countries. Nancy Sutherland maintains a monthly schedule of field trip information posted by schools throughout the Internet, and sends this schedule to interested teachers, so that if an upcoming field trip will yield information pertinent to a particular class' curriculum, questions can be sent to the children scheduled to take the trip to answer while on the outing. Electronic fieldtrips can also be taken and shared without leaving the classroom, as students exchange information about the places in which they live.

Expeditions taken by experts are also shared on the Internet. The *International Arctic Project*, a "multinational expedition across the Arctic Ocean by dog sled and canoe," is described and updated by teachers involved with the World School for Adventure Learning through the *Kidsphere* LISTSERV group. During an expedition undertaken by two explorers from the United Kingdom, participating classes received weekly, detailed descriptions of the progress of the team, what they experienced, and the challenges that they faced. When the successful explorers visited the U.N. for a heroes' welcoming party, there was a wall of electronic mail waiting for them from children all over the world who had, in a sense, been vicariously experiencing the expedition.

Pooled Data Analysis

Information exchanges are particularly powerful when data are collected at multiple sites, then combined for numeric and/or pattern analysis. The simplest of these types of activities involve students electronically issuing a survey, collecting the responses, analyzing the results, and reporting their findings to all participants. Pooled data projects have also included:

- *water acidity projects*, in which rainwater or stream water is collected at different sites, tested for acidity, then examined for patterns over time and distance,
- the *Global Grocery List* project, coordinated by David Warlick from the North Carolina Department of Public Instruction, in which students compare prices of 15 standard items (such as rice, sugar, eggs, and unleaded gasoline), then attempt to deduce reasons for price differences,

BEST COPY AVAILABLE

What's the tallest structure you can build out of 3/4" wide popsicle sticks that can:

1) support a Grade A Large egg and
2) withstand the Big Bad Wolf Test (the biggest lungs in the room blow on it as long and hard as possible; if the structure stands, it passes)?

We at the Playing to Win Saturday Science Project challenge you to come up with interesting, strong structures to perform this engineering feat!

*Use only Elmer's Glue for adhesive.
*Egg must be hard-boiled, with the shell intact (with yolk inside).

Figure 2. An Example of Online Parallel-Problem Solving.

- the *Column Count* project, coordinated by Joyce Rudowski, a teacher at the Cincinnati Country Day School, in which students from different cities measure the number of inches devoted to newspaper stories on different topics, then compare space allocations among sites,
- and the *Tele-Olympics*, coordinated by Linda Delzeit from the Cleveland Freenet, in which students at many different schools conducted Olympics-style athletic events, then submitted the statistics generated to determine the winners for each *"virtual event."*

Clearly, this type of project holds much promise for involving students in large-scale research efforts that use mathematics to answer complex and interesting questions.

Problem-Solving Projects

Problem-solving can take on exciting new dimensions in educational telecomputing environments. Activities can be either competitive or collaborative.

Information Searches

In this type of online activity, students are provided with clues, and must use reference sources (either electronic or paper-based) to solve problems. For example, Tom Clauset of Winston-Salem, North Carolina, developed the *GeoGame,* in which each of 20 participating groups of students provides the same eight pieces of information about their school's location (i.e., latitude, time zone, population, direction from capital city, etc.). The coordinators of the game then scramble the city names, and all groups use reference materials such as maps, atlases, and books to match the cities with the information sets. The winning class is the class with the most correct matches.

Electronic Process Writing

Students in Trevor Owen's English classes in Montreal, Quebec (Canada) regularly posted the poems that they had written to newsgroups sponsored by Simon Fraser University, so that other students in Canada could offer feedback in an electronic version of *process writing* sessions. Mr. Owen was also able to enlist the assistance of professional writers, such as the poet Lionel Kearns, to offer constructive criticism, and to receive some of the same, in response to pieces in progress.

Parallel Problem-Solving

With this kind of activity, a similar problem is presented to students in several locations, which they solve at each site, then share their methods electronically. For example, Carmela Federico of New York, NY, presented an architectural challenge online as shown in Figure 2.

Sequential Creations

Expressive problem-solving can be experienced with many students working on the *same piece,* rather than the *same collection.* Students on the FrEdMail network, for example, collaboratively created a "Global Peace Poem" (conceived and coordinated by Yvonne Andres and Mary Jacks) that circled the globe several times. Each class of students in each location added a stanza after having read the verses that other classes had previously appended to the (electronically epic) poem.

Simulations

Online simulations are perhaps the telecomputing projects that require the most coordination and maintenance, but the depth of learning possible and task engagement displayed by participants can convince project organizers to spend the additional time and effort necessary to make them work. A notable example of a successful online simulation is the *Centennial Launches,* sponsored by the Cleveland Freenet's *Academy One* project, which was described in an electronic newsletter as shown in Figure 3.

Social Action Projects

The Internet can serve as a context for "humanitarian, multicultural, action-oriented telecommunications projects" which involve the future leaders of our planet: our children. The *PLANET Project* ("People Linking Across Networks") involves representatives from a consortium of large Internet-accessible educational networks. These participants work together to create collaborative, meaningful social action

CENTENNIAL LAUNCHES: Simulated Space Shuttle Program -
At the core of these launches is a permanent full-scale mock-up of a space shuttle (called the "Centennial") complete with "Mission Control" which is located at University School in Shaker Heights, Ohio (Cleveland area). Schools around the world take various roles in each simulated space shuttle mission. These could include being another shuttle (doing a docking maneuver), secondary mission control, alternate landing sites (weather stations), solar disturbance observatories, and so forth.

Coordination and communications between the shuttle's mission control and other schools will be conducted through distributed conferences on the individual NPTN systems. Electronic mail is sent back and forth, hourly reports are posted, even real-time electronic "chats" can occur between mission control, astronauts, and supporting units.

Figure 3. *Centennial Launches*, an Online Simulation Sponsored by the Cleveland Freenet's *Academy One*.

projects in which children have primary responsibility for learning about and helping to tackle global issues of critical importance, such as hunger, violence, environmental pollution, and disease.

During the first months of operation, PLANET participants wrote petitions to the United Nations to protest conditions in Yugoslavia, brainstormed ideas about how to address the starvation and political unrest in Somalia, and planned for and carried out fundraising efforts to raise money to help to purchase "rope pumps for villages in Nicaragua that do not have access to clean water." The potential for multidisciplinary, forward-thinking, truly collaborative learning in becoming involved in projects such as these is awesome. As David Nafissian, PLANET Across-Network Facilitator, has written, "a single voice crying out is difficult to hear. But our collective voice can make an impact!"

Structures for Powerful Experience

The ideas behind these sample curricularly-infused telecomputing activities are simple, yet powerful. Their power rests in the interconnectedness that participants experience while they are communicating across what were once geographic and temporal boundaries to collectively realize meaningful, shared goals. This, along with the energy, enthusiasm, commitment, and patience of the teachers and students who help to bring these plans to life, is probably the key to their inspiring success. For successes like these to proliferate in precollege settings, effective models for curricularly-based telecomputing activity design and implementation must be provided.

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Identifying and Evaluating the Benefits of Educational Telecomputing

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Many papers have been written about the use of electronic communication in education. Most have assumed that use of this aspect of new technology is valuable, but few attempt to uncover the aspects that make it valuable within education. This paper aims to refine a view of the potential benefits of electronic communication and thus become valuable for focusing evaluations. Only through carefully evaluating and improving applications of new technology can we develop this field which has so many interesting pilots but few mature applications.

This paper will take electronic communication to be the use of computers to communicate outside the classroom, either to work with others or to obtain information. Although this excludes a range of services based on normal telephones or satellites these do not involve the use of computers. This paper will restrict itself to computer-mediated communications. Electronic communication can best be described as a range of services available to individuals and institutions.

The Potential of Electronic Communication

The potential of electronic communication is related to its potential audience: it is world wide. Where students are given access, they can ignore the walls of the classroom and make direct contact with others across the world for collaborative work and in so doing appreciate the differences in culture and yet the similarity of people. Communication is a central activity within education and thus electronic communication can be applied to almost any area. Fundamental aspects are: written communication, presentation of information for different audiences and/or research. The activity is essentially pupil-centered and mixed ability. Group work is hard to avoid, unless bibliographic research is the only activity. Communication with those outside the classroom is tremendously motivating for both pupils and teacher and this to a large extent justifies the extra time and effort spent on the process (Coyle and Harrison, 1993).

Electronic communication also has an important benefit for those with communication difficulties. While such people have many reasons for their difficulty electronic communication can provide them with an important channel. Their context is frequently so different from that of a normal pupil that people with whom they communicate will have made many assumptions before the first message is received. Prejudice arises between cultures. Electronic communication removes this bias while being particularly suited to their strengths. For example, one of the first electronic mail projects in Northern Ireland had the important side effect of increasing the integration of the pupils from a special school with their local schools.

Students can also become apprentices in a number of fields: collecting data and interpreting it with other pupils and scientists (Ruopp et al, 1993); working with an author to write novels; collecting articles and producing a newspaper (see later case study); in humanities using real information sources provided by pupils in another location and returning the favor for those pupils (see later case study). The interconnection of learners provides them with an audience for whom they will write, possibly in a target language which is that of their audience, but not their own. While these activities are possible using traditional post or visits the timeliness of the communication permits learning to take place within the attention span of the pupils and the school timetable. Information provided by pupils in another location is not mediated by the publishing process and such 'raw' data is frequently more relevant to the pupils than that in a text book. Where time permits additional questions can be posed to explore the data and correct misunderstandings.

The style of communicating through electronic mail or computer conferencing where messages are read, an answer composed and returned without the recipient waiting around permits the process to become more reflective. The students can review their next communication for half an hour if they wish, and yet the communication remains timely in a way that is rare with letters. Similarly shy participants may be facilitated because they do not have to confront their audience in person.

For point-to-point communication such as DeskTop Conferencing the last point does not apply. Instead the communication process becomes intense with participants focusing on both the immediate changes visible on the computer screen and the personal contact of the voice (Davis, 1993b).

Electronic communication has potential benefits for teachers and teacher education (Meadows, 1992). It permits collaboration across distant schools and with those in higher education. Discussion groups on the Internet hold a large volume of discussion about curriculum, educational practice and theories. Such discussion can provide a wider range of viewpoints and suggestions for developments or solutions to common problems. However as they are not edited they require sifting.

It is also important for the reader to note that electronic communication does not easily fit in with traditional classroom practice:

> "By its very nature classroom use of communication technology is contrary to the notion that learning occurs in isolation and is teacher-centered. For effective employment of this technology, teachers must be comfortable with the technology itself, value its potential, be process oriented, work cooperatively, and allow students to do the same." (Szymanski, Sunal, Sunal and Sheffler, 1993)

Like most applications used within computer based learning, electronic communications will support the teachers who wishes to move into a support role and permit their pupils to develop autonomy and information skills rather than absorb knowledge under the teachers' direct mediation. Unlike other applications it is almost impossible to use it without such an approach. Multi-site implementations make evaluation exceedingly complex especially as each evaluation should relate to the needs at each site and these inevitable change over time.

Research on the Effectiveness of Electronic Communication

Research into computer based learning is fraught with difficulties. The research monograph published by Society for Technology and Teacher Education describes the stages that the research has gone through and provide several chapters on approaches that can be taken. While such strategies are appropriate to electronic communication, it is also a more complex area to research and evaluate.

There has been relatively little hard research into the benefits of electronic communication. Betty Collis reviewed the evaluation strategies described in more than 120 projects involving telecommunications for distributed learning at the secondary level and concluded that 'evaluation is apparently difficult to do'. Of those projects which did attempt evaluation most was impressionistic or attitudinal. Collis (1993) discusses these difficulties and suggests a strategy related to success indicators, (long and short term; planned and unplanned) and the relation between these and the assumptions and observed characteristics of the context.

The Practice

The speed and potential immediacy of information regardless of distance are an important motivator and provide participants with an audience which improves relevance of the work, access to resources and self esteem. Issues relating to equal opportunities and multicultural experiences have been addressed through sharing work outside the institution, especially across borders. There are numerous projects which testify to the motivation and sustained use of electronic communications across countries. Such projects are also high profile. Dr. Roger Austin of the University of Ulster has been particularly successful in sustaining communications and has integrated them carefully into humanities courses which lead to recognized exams in more than two countries, as in the European Studies Project (Austin, 1992).

In an international conference which discussed the rights of children to electronic communication many teachers shared their aim to use electronic communication is education for mutual understanding in a world torn by conflict. While such a right is not as important as that of health care, it could be an important infrastructure to assist new generations to overcome prejudice (Davis, 1993a).

Time differences can be overcome due to the way in which messages can be stored until 'called' for and yet communications is fast enough to support group discussions. This is important across both time zones and timetables. Yet the delays inherent in asynchronous communication also remove some of the immediacy and flow of communication. In contrast, the ease and availability of information for multiple distribution and re-working is clearly important to some projects too. For example, the *Campus 2000 Newspaper* days remain popular over many years with support from Times Newspapers providing access to professional sources of up to the minute 'raw news' and a competitive environment with prizes to match.

To summarize, those who benefit from communications appear to be:

- distributed people or organizations;
- those keen to gain experience outside their location and who are prepared to use a flexible learning strategy; distance learners who want to communicate;
- people with a communications disadvantage;
- libraries keen to disseminate work;
- people willing to provide mutual self help and facilitate social change;
- people with little or no assessment requirement.

The Issues

Most positive points have been known for some time. The recent developments in our understanding relate to the factors which inhibit communications. It has become clear that they are not easy to sustain in education. The published cases referred to have had considerable input of enthusiasm, planning and resources and still many have failed. The reasons are rarely technical but more often human (Meadows, 1992; Davis, 1989).

The most important factor is the need to communicate. For some the need is transient, e.g., a Newspaper day. However, if communications is to become an ongoing activity rather than an occasional 'binge', then each participant needs to make it part of their working day. Older forms of communication have established routines: the phone rings, the post arrives. Electronic communications frequently requires the user to develop new habits and it lacks simple conceptual models, thus making it harder for participants to develop a natural structure to their use. New practices in relation to teaching and learning also need to be established, so purposes must be very clear and relate to all participants' agendas.

Access is a second major issue. Access must be easy preferably in 'home' area with proper training and support. The software interface should mirror as closely as possible that in common use by the participants. Telephone lines also need to be accessible to both teachers and learners for maximum use. Learners who can only communicate when their teachers are present loose much of the power of this medium. Many of the projects note that the depth of knowledge, self esteem and autonomy developed by students who control the communication themselves, with teacher support and supervision. While this is not unique, it is a more extreme case than with other Information Technology applications.

Most projects involve group work and group work across remote sites causes difficulties of its own. A 'match maker' and consultant has proved powerful even where communications are part of a course. In addition groups benefit when someone takes on the role of organizer directing the communication, so that interaction develops. A help desk is also useful initially, but less important when other participants can offer advice. For these reasons centralized systems have advantages, but access to facilitators is more important than centralization of the technology. Regulation of the size of a working group will provide sufficient communication an avoid it overwhelming participants.

Impoverished information, such as that communicated by text alone, is not easy to use and it disadvantages those with poor or unconfident written skills. However, the use of written communication does assist those who have difficulty communicating orally and this includes those with communication difficulties as in the Chatback project. In the United Kingdom Project GEMENI has stimulated the use of more than one telecommunications channel to good effect, for example both satellite and fax, as has the Exeter University Computer Conferencing Project. One form of electronic communications can complement the other.

What Will the Future Bring?

Many of the factors noted above for the relatively simple communications available today will be just as relevant to multimedia networks. Most of all electronic communications need to be evaluated in some detail to identify the range of teaching and learning strategies that it can support, plus the issues that needs to be addressed to improve the success of implementation for both short term and long term use. Such research will overlap with the use of technology in education, but it is more complex because it involves the differing needs of a number of institutions and actors. Service 'facilitators' and group organizers will be important and hopefully such people will also be able to provide professional development for staff wishing to adopt communications.

Currently there are no educational rates for telecommunications. More equity for participants is urgently required, possibly providing links into adult education and training. Institutions of initial teacher education could be important to support development across all levels of education. In the UK, at least, there is an urgent need to provide more support to student teachers out in schools, due to an increase in school based training. Perhaps this urgent need will provide the stimulus and education for a flexible teaching force which will be aware of the role that electronic communications could play in education.

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Factors Affecting Incorporation of Telecommunications into Teaching Practices: Circumstances and Experiences Leading to Change

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The general consensus of the public and the media is that our schools have changed little in the last one hundred years.

> Schools are out of step with the times. Inside and out, schools today look very much the way they did a hundred years ago: the buildings, the size and shapes of classrooms, the divisions based on age, and the ways of "delivering" instruction have changed very little. Yet the world has changed remarkably. Families, jobs, social organizations, and entertainment look nothing like they did at the turn of the century. From inside a school, however, one would hardly know that visual images, rapid motion, technology, and change are pervasive in the world outside. (David, 1991, p. 37)

The lock-step approach, where everyone learns the same thing at the same time, is no longer adequate. Sheingold (1991) stated, "Schools must find ways of diagnosing students' strengths and weaknesses and must devise programs that build on students' strengths, allowing them to pursue existing interests, cultivate new ones, and get help when they need it" (p. 19). Active learning strategies must be incorporated into the planning and delivery of instruction, and instruction should center around an integrated curriculum. Additionally, students should be given opportunities to take responsibility for their own learning and to see results based on their strategies for learning (Wang & Palincsar, 1989). If change is to occur, teachers must have the flexibility to make decisions about the change based on circumstances, and the time to think about the innovation and how to use it (David, 1991).

Technology, when integrated into the curriculum, has the potential to break the "lock-step" mold (Collins, 1991). Technology engages students in learning things relevant to them and facilitates small group instruction. Researchers (Sheingold and Hadley, 1990; Irving, 1991; Becker, 1993) found that when technology is used in classrooms, teachers can become coaches or facilitators who guide and monitor student learning. Student assessment changes from individual performance on tests to assessment based on products, progress, and effort. Students research topics of interest and consult with other students, teachers, and experts from around the world. The social structure of the classroom changes from competitive to cooperative and repeated failure is eliminated.

The development of learner-based software has contributed to the relevant use of computers in classrooms. Through the use of learner-based software, students focus on process rather than product creating a three-way interaction between the teacher, computer, and student as illustrated in Figure 1 (Bull and Cochran, 1991). Through telecommunications, students and teachers extend this three-way interaction and increase their realm of experiences as they tap the expertise of peers and experts around the world (David, 1991; Sheingold, 1991; Levinson, 1990).

However, Becker (1992) found that teachers needed assistance on how to integrate technology into teaching practices and Kerr (1989) suggested that teaching models be developed to demonstrate what is possible under real

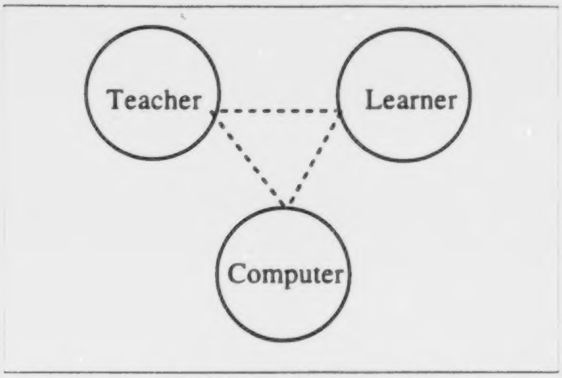

Figure 1. Three-Way Interaction (Bull and Cochran, 1991, p. 52).

conditions. Realizing that teachers needed training and support, the University of Virginia initiated a collaboration between the Virginia Department of Education and public school divisions in Virginia to develop ideas for integrating telecommunications into instructional practices. This initiative, the Electronic Academical Village Project, spanned two years, and during that time patterns of use emerged. It was discovered that some teachers who had training, support, and access to equipment in their classrooms employed telecommunications while others did not. The primary focus of this study was to discover circumstances and experiences that led teachers to incorporate telecommunications into their teaching practices while others in similar circumstances did not.

Research Design

All of the participants in the initiative were elementary classroom teachers who had been recommended by their school division as being positive toward technology and innovative in their teaching practices. Participants had a Macintosh computer, a modem, and a dedicated phone line in their classrooms, and received monetary compensation for attending training workshops. Six teachers were asked to participate in the study, and selection was based on the levels of participation in project activities. Three had relatively high levels of participation, as demonstrated by frequent contributions to electronic conferences and the initiation of additional networking activities, and three were selected based on their lack of participation. Individual case studies were developed and consisted of guided interviews with the teacher, his/her principal, and a facilitator who had been assigned to the teacher for technical and curricular support.

Interviews with teachers centered around gathering data on how the teachers were using Virginia's Public Education Network (Virginia's PEN) in classrooms and what contributions (if any) the teacher had made to the conferences of Electronic Academical Village. The teachers also described the impact telecommunications was having on their students. Principals were interviewed to uncover extenuating circumstances that might be affecting teachers' use of telecommunications, and interviews with facilitators focused on the types of support and training teachers had requested, how facilitators had responded to the requests, and how they had promoted use of the network. Data were collected from February 1-April 1, 1993.

The content analysis format developed by Newlove and Hall (1976) was used to determine the *Stages of Concern* of the teachers and a framework developed by Hall, Loucks, Rutherford, and Newlove (1975) was used to determine the teachers' *Levels of Use*. The data collected from the interviews with the principals and the facilitators were analyzed using content analysis to identify common patterns and themes (Patton, 1990). Through cross-case-analysis, the circumstances and experiences of high users were compared to determine commonalties and differences, and the same was done for the cases of the low users. The two sets of data were then compared, and the patterns which apparently led teachers to incorporate or exclude telecommunications were identified and reported.

Credibility was established through triangulation of sources, peer debriefing, member checks, and thick description (Lincoln and Guba, 1985; Patton, 1990; Yin, 1989). A peer debriefer read the transcripts and each cross-case analysis to independently identify emerging themes and patterns and to determine if the data were reported accurately and fairly. In addition, participants were given the opportunity to check their transcripts for accuracy. The method of data collection was chosen to provide enough information to create a thick description and increase transferability.

Findings

Based on the information collected, the following circumstances and experiences contributed to the incorporation of telecommunications into teaching practices:

1. Valuing the use of an interactive learning network
2. "Figuring out" how to integrate telecommunications into the curriculum
3. Support from other computer-using teachers
4. Access to equipment at home
5. A stable work environment

Teachers who were incorporating telecommunications into their teaching practices valued the network for use with students and were comfortable using telecommunications software. They were described by their principals and peers as excellent teachers who were learners themselves. They were open to new ideas and willing to try new things to increase student learning. They invested time to incorporate telecommunications into instructional plans because they felt it was important to engage students in these activities. Teachers who were struggling with basic technical procedures were less willing to incorporate telecommunications into their teaching practices because they were uncomfortable using the telecommunications themselves.

The third contributor was support. High users taught in schools where other teachers were engaged in telecommunications activities and were using computers as multipurpose tools. They also received support from their facilitators and attended the workshops of the Electronic Academical Village to form connections with other project teachers. The low users did not take advantage of opportunities to learn or initiate contact with those who were assigned to assist them.

It appeared that the lack of computers at home curtailed the networking activities of the low users. All of the teachers who were high users had computers and modems at home as compared to only one of the low users.

Transition also may have contributed to low use. All of the low users were new to their roles. Two were new to the teaching profession and one, though a very experienced teacher, was in a new role as a technical support person at her school. In addition, two of the low users were at newly-opened schools and may have been overwhelmed as they adjusted to new situations.

Circumstances that Did Not Seem to Impact on Use

There were several circumstances that did not seem to impact on use. They were:

1. The number of computers in the school
2. The principal's level of knowledge and interest in telecommunications
3. The actions of the facilitators

The first unexpected noncontributing factor was the number of computers in the school. The user with the highest level of participation taught at a school that was old and had little equipment. The second highest user taught at a school that was described as being "state of the art," but it only had one modem. Of the low users, two taught at schools that were new. Every classroom was equipped with a computer and a modem, but the teachers did not know how to use them. Based on these circumstances, it seemed appropriate to conclude that the number of computers, modems, and phone lines did not sharply influence participation in a telecommunications project. Training and support appeared to have a greater effect than levels of equipment.

The principal's level of knowledge, interest in telecommunications, and style of leadership also seemed to have little bearing on teachers' use. Of the high-using teachers, only one principal had an electronic-mail account, and he was an infrequent user. Of the low users, one principal was an active user and the other principals had limited knowledge of Virginia's PEN. The principals' style of leadership also had little impact on use. One principal was actively involved and conducted training workshops on telecommunications, while another let the teachers decide if they wanted to use telecommunications. One principal arranged for mandatory workshops on telecommunications while other principals relied on the teachers involved in Electronic Academical Village Project to provide training and support. *Levels of Use* did not reflect the principals knowledge, level of interest or style of leadership.

Also, the actions of external facilitators assigned to assist teachers did not seem to influence the teachers' use of telecommunications. Two of the most active users had facilitators who were not actively engaged in leadership roles, and two of the most active facilitators were not successful. One facilitator lacked technical expertise and was not able to fully assist the teachers in her group.

The Concerns of High and Low Users

Four major concerns were expressed by both high and low users and their facilitators. They were:

1. Time
2. Access to equipment and local nodes
3. Training
4. Lack of specifically stated protocols

Time was mentioned by every participant in this study. They were concerned with the amount time necessary to become familiar with the network and to plan lessons involving telecommunications. Access was the second major concern. The participants expressed concern over not being able to access their local network nodes during the school day because the lines to the local nodes were busy. Lack of phone lines were also a concern.

Learning to use the network instructionally was also a concern, and participants suggested that instructional models be developed to assist new users. Demonstrations by teachers who were using telecommunications were also recommended. Participants also suggested that training for high and low users be changed. More advanced users could collaborate on projects for implementation on the network while new users assisted each other with basic procedures. Step-by-step lesson plans for telecommunications projects was also recommended.

The absence of specifically stated protocols for posting was also a concern. Lack of explicitly stated rules caused teachers and students to post incorrectly and different threads of the same discussion resulted. The teachers suggested that the conferences be moderated and misposted articles be moved to the correct place.

Relating Results to Prior Research

Marker and Ehman (1989) found that when implementing a technological innovation, it was critical to select teachers "who believe in the potential benefits of technology" (p. 28). In this study, teachers who were integrating telecommunications into their teaching practices valued the use of an interactive learning network because they recognized the potential the network had for enhancing instructional practices and increasing student learning. Riel (1990) supported the teachers recommendations of specific lesson planes. The teachers who were not incorporating telecommunications into their teaching practices were not taking advantage of opportunities to learn and were not interested in using the network to increase student learning. Also, high users had made changes to integrate telecommunications into the curriculum, and this was substantiated by Becker (1992) and Shavelson, Winkler, Statz, and Feibel's (1985) research.

Sheingold and Hadley's (1990) research also supported the findings of this study. They found that teachers who were integrating computers into their instructional practices had spent a considerable amount of time learning how to use computers and had become comfortable using them. Sheingold and Hadley (1990) also reported that the key incentive for use among teachers was the desire to create an environment where students were engaged in their own learning and use computers effectively. Teachers reported that the focus of instruction had shifted from teacher-centered to student-centered and their perception of student performance had changed.

Becker (1990) also reported that teachers who were considered to be exemplary computer users taught in more resource-rich environments. However, in this study, this was not entirely true. Two of the low users taught in newly opened schools which were described as being "state-of-the-art." These teachers may not have been using telecommunications because they were in transition, but neither indicated that they were interested in using telecommunications in the future.

The findings of this study did not fully support Hall and Hord's (1987) research on the role of the second-change facilitator, who in this study were the project's facilitators. According to Hall and Hord, an active facilitator contributed significantly to the successful implementation of an innovation. However, in this study, the role of the external facilitators did not appear to influence participation in the projects of the Electronic Academical Village.

Implications

Future research should focus on the relationship between a teachers' view of curriculum and the incorporation of telecommunications into teaching practices. Did the teachers who were successfully integrating technology into teaching practices change their views on curriculum, or did their views on curriculum support the use of telecommunications?

Further research is needed to discover what types of technical and instructional support are necessary to sustain long-term use of a telecommunications network. In addition, other research needs to focus on who to support. Although there is a strong push to use computers, some teachers are unwilling to use them. Research is needed to discover the characteristics that make teachers interested in using computers and incorporating telecommunications into teaching practices.

Further investigation is also needed to discover if transition is important. Is transition an important characteristic for not using telecommunications? If it is, should teachers who are in transition be excluded from telecommunications projects?

Finally, longitudinal studies of the impact of the use of telecommunications on student learning should be conducted. Considering the cost, is this a viable instructional tool? Would increasing the number of computers, phone lines, and modems directly affect student learning?

Conclusion

This study has explored the circumstances and experiences that lead some teachers to incorporate the use of telecommunications into their teaching practices, while others do not. The findings indicated that teachers who were integrating telecommunications into their teaching practices valued the use of an interactive learning network and had figured out how to use it instructionally. They had also received support from other users and had access to equipment at home. Being in transition appeared to have a negative impact on using telecommunications.

Circumstances and experiences that did not appear to have an impact on use were the number of computers in a school, the principal's level of knowledge and interest in telecommunications, and the actions of the project's facilitators.

The major concerns expressed by the participants were: time, access to equipment and local nodes, training, and the lack of specifically stated protocols on network conferences. These findings should be useful for all who wish to promote the use of interactive learning networks to enhance instruction.

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Use of Telecomputing to Support Group-Oriented Inquiry during Student Teaching

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I have learned so much from my peers. Sometimes when I'm reading someone's e-mail entry, I picture all of us back [on campus] in Chambers Building sitting in a circle discussing all kinds of topics. I value what my peers have to say and this project has helped me hear them. Kathleen (11/1/92)

In exploring the changing role of educational supervision, researchers call for a shift from occasional outside supervisory assistance to reflection and continuous collaboration among support networks. In addition, the reform calls for movement from teaching as an applied science of generic formulas to professional inquiry based upon pedagogical content knowledge and unique teaching contexts (Gordon, 1992; Holland, et. al., 1992; Nolan and Frances, 1992). While much of the recent literature in teacher education advocates a collegial, constructivist approach, novices continue to enter a system where seclusion behind one's own classroom door is often the norm. Little (1987) heralds the plight of such teachers, colleagues in name only, who "work out of sight and hearing of one another, plan and prepare their lessons and materials alone, and struggle on their own to solve most of their instructional, curricular, and management problems" (p. 491).

Yet another area where teacher education programs have been cited as falling alarmingly short is in application of technology. While uses for technology in the information age are advancing rapidly, Brooks and Kopp's (1990) review of the research in teacher education concludes that "undergraduate teacher-training institutions are not taking a convincing or focused leadership role in identifying solid evidence about the application of technology to teacher training" (p. 499).

Driven by the desire to combine the need for field experience supervision which is more collegial and constructivist in nature with the potential for inclusion of technology into the reflective process, we engaged in a study designed to join preservice teachers, their supervisors, and university faculty in group-oriented inquiry during the student teaching. The study was conducted using the PENN*LINK communications and information network, which connects the state's 501 school districts. The central purpose of the research was to determine the effectiveness of electronic mail to support the supervisory process, connecting key members of the student teaching experience who are ordinarily separated by distance and time. Rather than experiencing isolation, preservice teachers could interact weekly, forming a shared educational community with opportunities to discuss the practical issues that arise in schools.

Methodology

This qualitative study occurred over a fifteen-week student teaching semester. Sources of data included an initial and exit questionnaire, interviews, weekly quantitative usage data, including log-ons to the system, connect hours online, number of messages sent, and their date and destination. In analyzing the data, we focused primarily on content analysis of the artifacts or actual messages which were automatically forwarded to a central file. The participants were fully aware of and had granted consent to having a copy of all their electronic communications retained for access by the principal researchers in the project. Because of ethical concerns as to the privacy of those involved, all participants were also issued a confidential user identification address.

The group included 19 secondary preservice teachers from two student teaching centers located in southcentral and western Pennsylvania. They were organized into five subgroups according to disciplines: 2 science, 3 math, 5 social studies, and 7 English. The remaining preservice teachers, one from the foreign language department and one from music, teamed together. Each participant was loaned an IBM computer, printer, modem, word processing and telecommunications software, and provided with a PENN*LINK account and toll-free access into the network.

Students were required to send three messages per week. One assignment was to share a plan either before implementing it or following the teaching period with comments reflecting upon what had occurred. A second assignment was open-ended, used to initiate some type of discussion. Students could share a success, seek advice in solving a problem, ask a question, or initiate a debate on some issue of interest. Finally, students were asked to respond to another message they had received. Messages and responses could be addressed to the other members of one's content subgroup (which included the supervisors and content faculty member), to a single individual, or to the entire pilot group.

Usage Data

The use of electronic mail far exceeded our expectations or requirements. Analysis showed that preservice teachers' enthusiastically responded to electronic mail as a medium of communication and reflection about teaching. The 19 preservice teachers and their two supervisors averaged 145 log-ons per week or 6.9 per person/per week, almost daily usage of the communications network. They sent an average of 244 memos per week, or 11 per person/per week, 8 more than was required. While the average connect hours of 44 hours per week or 2 per person/per week provide some indication of time spent writing, reading, and responding, this number is deceptive because some preservice teachers uploaded/downloaded material from their word-processor, while others less adept with the system took longer by conducting all written communication online.

Ironically, the enthusiasm with which the group responded to network communications led to the most frequent complaint about the system. As a result, many times the preservice teachers expressed frustration at the number of messages awaiting them when they logged-on to the network. While researchers have noted this information overload in other studies involving electronic mail (Hiltz, 1984; Harasim, 1987), Harasim's findings indicate that when engaging in interactive computer networks, there are "no easy solutions to avoiding the trade-offs between the value of open communication and the cost of information overload" (p. 130).

Group Supervision: Qualitative Findings

Far more interesting than the quantitative data, however, are the results of content analysis of the messages forwarded to the central research file. In interpreting the data, the evolution of a coding scheme emerged into three general categories as follows: a) combating frustration with camaraderie and support; b) promoting a focus on content-specific pedagogy; and c) forging the way toward critical inquiry into practice.

Combating Frustration with Camaraderie and Support

E-mail is an outlet for the frustration that so many student teachers feel. It is also an easy way to keep the lines of communication open. If I ever had a question or concern, right away there were other opinions to get some thoughts running through my head and get me on my way toward solving the problem. Lorena (10/24/92)

As the semester began and the preservice teachers faced the challenges of taking over classes, many of them utilized their weekly "open" entry and response as an outlet for frustration and a vehicle to offer one another camaraderie and support. As the participants grew more comfortable with one another and a spirit of collegiality grew, they ventured beyond support statements to offer suggestions. In the following exchange, one of the math preservice teachers shares his first experience with a teary-eyed eighth grader and receives subsequent advice on handling the situation:

> *Boy, did I have a terrible day on Friday! I couldn't seem to do anything right. It was the day after I had given the class a speech about how they should never be afraid to ask questions, there is no such thing as a stupid question, and the only way I can help them is if they ask. I was pleased to see more hands were going up. Anyway, one girl asked a question. It was a simple question and I had just gone over the answer, but I was certain she wasn't the only person in the class who didn't understand, so I explained it again. She still didn't get it, so I asked another student to come up and explain it, thinking that maybe it would be easier to understand if she heard it in another student's words. The student was almost finished with his explanation when the girl began to cry loudly, saying, "I'm so stupid. I'm the only one who doesn't understand." Her self-esteem has got to be totally shot. Has anything like this happened to any of you? How did you handle it? Also, what can I do to rebuild her confidence? Jody (10/10/92)*

> *Jody, you were and still are in a tough position. I think I would have done what you did. What to do next is certainly a big question. If I were you i would just try to give the girl some easy opportunities to succeed to build her confidence back up. One way might be during review. Good luck and keep me posted. Matt (10/11/92)*

Jody, Wow! One thing that came to my mind was that having another student explain the answer might have set her off because she saw that student understood and if that one did maybe everyone else except her did too. In order to boost her confidence, try to call on her when she has a good chance to show success. I know this is difficult. I have a couple of students who do not have much self-confidence. I feel I put them at risk every time I call on them, but I must involve them. One thing to watch out for. . . don't just call on her for the easy questions. This will be noticed by her and the class. Perhaps you could privately reinforce her for awhile. When she gets a good quiz grade, tell her how well she did one on one. Try to build the confidence between you and her first and then in class when she knows she is backed by you. Angela (10/11/92)

Within 24 hours of conveying his frustration and eliciting suggestions, Jody had two of his colleagues' viewpoints to consider as he proceeded. In addition to bolstering Jody's confidence with collegial advice, this type of opportunity for post-teaching reflection is supported by Elliott (1989), who states, "It is through practitioners' retrospective self-evaluations of their attempts to translate values into action that professional knowledge is further defined and developed" (p. 247).

Promoting a Focus on Content-Specific Pedagogy

I am able to adapt and use so many of the great ideas that people send out. I love to borrow everyone else's creativity. What a rich pool we have to work from! This is especially helpful to novice teachers because we don't have the years of experience behind us. Raeann (11/29/92)

In exploring the knowledge base for teaching, Shulman (1987) emphasizes the importance of including pedagogical content-knowledge, or the amalgamation of content and instructional strategies which are unique to each discipline. By arranging the secondary preservice teachers into content-area subgroups with a university faculty member from each department to serve as a mentor, the participants were exposed to a much wider variety of ideas, techniques, and classroom experiences through the exchange of lesson plans and subsequent reflections than could be afforded by mirroring one's cooperating teacher alone. An example of content-specific pedagogy involves a science teacher's reluctance to engage in more discussion in his classes and the alternative perspective proposed by his peer:

It seems like math and science are quite different than the other disciplines when trying to incorporate discussion as a teaching strategy. In other subjects, the students seem to be able to discuss without really knowing all the facts related to a topic. This type of discussion would be a complete failure in my science classroom. How can students talk about the depletion of the ozone layer, for example, when they don't have a solid understanding of how it occurs and what causes it? It is absurd to think they are going to get anything out of a discussion except for more misconceptions. Maybe I'm missing something here. I need some input. Mike (11/7/92)

Mike, I believe we really need to integrate class discussions into our science lessons. I too am guilty of trying to figure out how to fit them in. We are always trying to cover all the relevant material and get on to the next section. But perhaps we can stop and give students a chance to discuss related topics. Sure most problems are so complex that one seems to never have enough information to understand them. Do you or I really understand some of the science topics? The more I learn about global warming the more I realize I don't really understand anything. But that doesn't stop me from wanting to learn more or discuss it on a level I can understand. Students can discuss almost any topic. You can help guide them and help point out misconceptions. WE can help them learn to use their minds NOW. We don't want to say that their opinion is unimportant because they don't know enough. We can teach them their opinion has more weight if they can back it up with research. Steve (11/7/92)

Steve was quick to make the issue of incorporating more classroom discussion a problematic one for further reflection. He addressed the issue of covering content versus discovery learning. Schon (1988) explains that such examination of practice is a requisite to reflective teacher education, for it "opens a person to confusion, to not-knowing - therefore, to a rejection of belief in externally given 'right answers'" (p. 23), allowing preservice teachers to craft their own knowledge about teaching in their content areas.

Forging the Way Toward Critical Inquiry into Practice

By reading and processing other people's opinions, I have been able to refine my own. E-mail has allowed a "community of scholars" to arise. Madeline (10/27/92)

Watts and Castle (1992) declare teacher development as a critical precursor to meaningful change in our schools. Their studies have confirmed the profound potential of technology to provide significant opportunities for professional development and thereby the transformation of schools. For example, one of the most interesting interchanges among the entire pilot group was sparked by a simple observation made by the Spanish preservice teacher concerning her experience with homogeneous grouping:

The first thing I noticed is the vast difference between the student I shadowed today, a motivated, level 5 senior, and the students I worked with in pre-student teaching, all unmotivated, lower level sophomores. It doesn't matter what the situation, a motivated student

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> *will learn, whereas an unmotivated student needs a teacher to step in and somehow catch their interest. Lorena (9/14/92)*

> *Lorena, I read your observation, and have an observation of my own to make. Did you ever notice how most teachers treat lower level students in the first place? Check out the way they interact with lower level students. I notice that teachers generally expect little of them. No wonder so many lower level students have poor self-images and attitudes about school. Kelly (9/15/92)*

The seeds sown by this initial exchange on the ethical implications of tracking and teacher expectations were referred to many times throughout the semester as preservice teachers questioned common practices:

> *The middle school where I teach divides students into three ability levels or tracks. My coop agrees with this policy because she believes it is easier to teach homogeneous ability groups. She tailors her lesson for the ability of the group. This means that the lower ability students do not cover the same material as the higher groups. We also seem to have more behavior problems with the lower groups. Perhaps this is because of the expectations they perceive. It seems many of the teachers expect problem behaviors from the lower students. This is the self-fulfilling prophecy we have heard about. What do you think? Steve (9/27/92)*

> *I have observed my coop, who has a high class and a low class, and he treats them really different. His expectations are so low for the slower students. In fact, he doesn't even try to challenge them and see what they can do. He doesn't expect any higher level thinking from them at all. I really think they are capable of doing much more than he has them doing, but he won't even try. He spends more time correcting the bad ones than he does teaching the good ones. It saddens me, and I am looking forward to trying new things with them to see what they can do. Tina (9/27/92)*

> *When I was a junior in high school I was in the lowest track for math while at the same time in an honors history class. My grades in math were Cs and Ds. My grade in honors history was an A every marking period. I know I could have done better in math, but I didn't study and I could have cared less. I viewed myself as stupid in math so why even try? I wonder how many of my own students are defeated before they even begin? Art (10/5/92)*

> *I come from a school system that tracked even in kindergarten. We were tested right before starting school, and unless you made some incredible change, wherever you started was pretty much where you stayed. I think that tracking can dictate a person's life. Madeline (10/7/92)*

The preservice teachers explored their own philosophy toward policies for tracking students, some of them reflecting back upon their prior experiences in homogeneous groups to explore the long-term effects. They appeared to conclude that gross inequities were inherent in such educational practice. As they continued to weigh what *is* with what *could be* in our schools, they worried if they could truly make a difference. A communication by Angela at the conclusion of the semester is representative of the group's thoughts:

> *Right now I am teaching my unit on problem solving. I developed the unit separate from the school's curriculum using the textbook only as a reference. My unit is to promote critical thinking in a cooperative atmosphere; the students are to look to each other as a resource. I am trying to promote mathematical curiosity and give the students high math self-esteem. This unit follows the theory I have learned from the NCTM standards. I am excited about teaching this unit - more excited about this than the curriculum I have been following. P.S. Are we the generation to make the new theories come true? Angela (12/6/92)*

"Are We the Generation to Make the New Theories Come True?"

I see e-mail as important in familiarizing teachers with the potential of technology and the use of the computer for communication. Jeff (10/27/92)

As Angela so aptly commented, a new generation of teachers is prepared to enter the profession. Rather than being socialized into a secondary school system where there exists little interchange among members of a department as teachers close their doors and work in isolation, the results of this study indicate that the participants have experienced technology as an effective means for personally linking educators for immediate communication about both general and content-specific pedagogy and for camaraderie and collegial supervision without the barriers posed by time and distance.

Cochran-Smith and Lytle (1990) determined that the missing link in the knowledge base on teaching is "the voices of the teachers themselves, the questions teachers ask. . ." (p. 2). However, the preservice teachers who took part in this study engaged in joining their voices for collaborative problem-solving and the social construction of knowledge based upon a shared pool of experiences that an artificial assignment for a professor or field supervisor alone could never foster. Everyone participating online during the field experience became an integral part of a forum for the kind of professional dialogue essential to a dynamic school environment that supports change. Watts and Castle (1992) conclude:

> As teachers discover the power of their talents, strengths, and voices within and beyond the classroom, they begin

> acknowledging to themselves and others that they are important professionals who can make a difference in their schools. (p. 685)

Our preservice teachers have demonstrated that within a telecommunications network lies the potential for the self-supervision necessary to empower teachers with a voice in shaping the future of education.

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Facilitating Reflective Thinking in Student Teachers through Electronic Mail

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Preparation of reflective teachers is an important theme in teacher education. During student teaching, many student teachers experience a sense of isolation as they leave the university environment. Not only do students leave the familiar surroundings of the university campus, but they are no longer in direct contact with other students or faculty who have been a source of support. Student teaching provides a unique challenge for integrating educational technology to facilitate reflective thinking in the teacher education program. The purpose of this study was to investigate the effectiveness of a research project that utilized electronic mail as a means of communication among student teachers, university supervisors, teacher education faculty, and participating classroom teachers. Specifically, we extended our previous study (Yan, Poage, Munson, & Anderson, 1993) to examine the effects of e-mail communication on student teachers' reflective thinking.

Theoretical Framework

Reflective thinking in the student teaching experience is an important component of enhancing student teachers' personal and professional growth. As far back as 1933, Dewey made reference to the importance of reflective thinking. Since Schon's research (1983), reflective thinking has received more and more attention in teacher education programs yet reflective teaching itself has not been well-defined. Common agreement regarding reflective teaching includes the following two elements:

(a) Content knowledge which refers to how teachers use knowledge in their planning and decision making and
(b) Mode of thought which refers to beliefs and dilemmas of teaching as well as the social outcomes of education

A broad body of research concerning reflective thinking in preservice and inservice teachers is in existence (e.g Cochran-Smith, & Lytle, 1990). Since Schon's research (1983), many efforts are underway to provide opportunities for reflective thinking in student teaching, for example: (a) a weekly seminar and (b) weekly journals.

Wedman, Martin and Mahlios (1990) studied the effects of a nine-week student teaching program designed to prepare reflective practitioners. Their results indicated that seminars, journal writing, and action research can help student teachers grow in reflective thinking. However, their study did not indicate the effect of individual components in reflective teaching.

Zeicher & Liston (1987) used journals as "an integral part of the supervisory process". The journals provided the supervisors with information about the ways in which their students think about their teaching and about their development as teachers, with information about classroom, school and community context. The journals also provided student teachers with a vehicle for systematic reflection on their development as teachers and on their actions in the classroom and work context. Bolin (1988) analyzed one student's reflective journal to look at how a student teacher developed a concept of teaching. To avoid the influence of the supervisor's comments, Bolin analyzed a "clean copy" of the journal.

Little is known, however, about the effectiveness of e-mail on enhancing student teachers' reflective thinking. It is our belief that regular, easy access (via electronic mail) to other student teachers and university supervisors will enhance student teachers' reflective thinking.

Method

The following section describes the subjects, procedure, and data analysis used in this study.

Subjects

A total of ten student teachers and six university supervisors from the Department of Teacher Education at a northwest university participated in this study. Given the exploratory nature of the study and the funding constraints of the project, we selected ten student teachers to participate in the program on the basis of the following criteria:

(a) interest in participating;
(b) student perception of the value of the study; and
(c) either experience with e-mail, or the willingness to be trained in the use of e-mail.

Procedure

Ten modems were provided for use in this project by the Department of Teacher Education. All participating students were enrolled in a block of methods courses before the project began. During the methods block a training session was offered to familiarize student teachers with the electronic mail (e-mail) system used through the VAX computer. They learned to set up a modem and to send and receive e-mail messages. Each student teacher received a username to access the University VAX and material covering the use of a modem and the e-mail commands. It was necessary for University personnel to make contact with the cooperating teacher and the school in which the student was teaching to locate a convenient phone line and computer access to the phone line for each modem. In several instances University personnel traveled to the school, installed the modem and taught the use of communication software to individual student teachers. Modems were installed on both Macintosh and IBM computer environments.

Guidelines for reflective thinking were also provided for the student teachers. These guidelines included:

(a) What were the essential strengths of today's lesson?
(b) What, if anything, would you change about the lesson?
(c) What, if any, unanticipated things happened during today's lesson?
(d) Can you think of another way you might have taught this lesson?
(e) List one specific area that needs work. What can I do to work on this area?
(f) Do you think the content covered was important to students? Why?
(g) Did any moral or ethical concerns occur as a result of the lesson?

During student teaching, the participants were asked to read their e-mail every day and respond as often as they were able or saw a need. Once a week, the student teachers responded to the reflective thinking questions provided to them during the training session.

Data Analysis

Based on a case study approach (Yin, 1984; Merriam, 1988), we collected and analyzed data according to the principles of qualitative research methodology. Specifically, e-mail journal writing served as the primary data source. University supervisors' observations were used as a means of cross-validating the findings of the study.

The student e-mail logs were saved and analyzed according to the following content categories:

(a) Reflection on adapting lesson plans,
(b) Reflection on the content/subject matter knowledge,
(c) Reflection on teaching strategies,
(d) Reflection on anxiety and stress in teaching,
(e) Reflection on class management,
(f) Reflection on the student teaching experience.

The university supervisor's e-mail communications to the student-teacher were analyzed as well.

Results

The data from the student e-mail logs were analyzed for content by 3 researchers. A 95% agreement among the researchers was obtained.

E-mail facilitation of reflective thinking

The content analysis focused on the following reflective thinking categories.

(a) Reflection on adapting lesson plans,
(b) Reflection on the content/subject matter knowledge,
(c) Reflection on class management,
(d) Reflection on anxiety and stress in teaching,
(e) Reflection on the relationship between student teacher and cooperative teacher,
(f) Reflection on sharing teaching experience.

Examples from student teachers' e-mail logs have been included.

Reflection on adapting lesson plans

> "I am really beginning to see that the agenda of each day can be drastically changed depending on the mood of the students... As a teacher, you really have to learn to roll with the flow of things!"

Reflection on the content/subject matter knowledge

> "Last week I did a unit on poetry... the kids read poetry from books and finally they each wrote their own poems and presented them to the class..."
>
> "I began a unit on the rain forest today... the kids were really excited..."
>
> "The kids wrote thank you letters thanking the tour people and telling them what they learned... I had to give a mini-lesson on letter writing first because they had no idea how to write a letter!"

Reflection on class management

> "All they want to do is play games and go to recess. My master teacher has the same problem with them. There

are quite a few behavioral problems in the class...I have also been trying to concentrate on saying positive things to the kids instead of always pointing out the negative things. Not only does this make the kids feel more successful in my opinion, it also makes me feel more positive about the class and my teaching."

Reflection on anxiety and stress in teaching

"I am feeling a bit tired already! That is not good. I find the kids difficult sometimes...Last week was not a good week for me... I think it was partly due to the fact that the kids were in their last week of taking the Basic Skills tests... Being their frustration level was high, mine was high also."

Reflection on the relationship between student teacher and cooperative teacher

"I prefer teaching the lessons I prepare when she is out of the room, for when she is in the classroom she is continually interrupting me while I am teaching. She is either bossing the kids around... or she is telling me things that I forgot to point out in my lesson... It becomes so frustrating for me and rather demeaning...There are quite a few behavioral problems in the class which my master teacher and I have not seemed to resolve completely yet. Perhaps we never will!... The kids only have one teacher to follow directions from instead of becoming confused by 2!"

Reflection on sharing teaching experience

"I began presenting my poetry unit today. The kids were so excited about it because I was able to 1) maintain their initial interest and attention, and 2) involve and engage them in what I was doing!"

In addition, it is evident from the student teachers' e-mail logs that they are primarily concerned with sharing their positive and negative teaching experiences with faculty and other student teachers. Although some of these experiences are related to the categories previously described, students appeared to want to share experiences outside these boundaries. The following categories emerged:

(a) Sharing solutions to problems
(b) Parent teacher conferences
(c) Admitting that they were wrong/don't know everything
(d) Sexual harassment

Sharing solutions to problems

"The kids behaved really well, but I think a lot was due to my explicitness in explaining what my expectations for the class were... I have had the kids work cooperatively in groups for some of the lessons I have planned... They seemed to respond quite well to it. I have them working in groups to create short stories for creative writing."

Parent teacher conferences

"It is very interesting to see why many of the kids operate the way they do. All I have to do is listen to their parents and it al becomes clear."

Admitting they were wrong/not knowing everything

"... Josh came up to me and insisted that he had passed his 7's times tables but I had not recorded it in my grade book and I had thrown all the sheets away so had no way to check...At first I told him he would have to do it again...I explained that I had probably lost his timing and asked him if he wouldn't mind taking his 7's test again tomorrow... This taught me an important lesson about how as teachers it is easy to not take kids' feelings into consideration, or to not admit when we make mistakes... I think Josh really needed to know that I believed him..."

Sexual harassment

"Yesterday we had a class meeting with the counselor because one of the 4th grade boys was sexually harassing one of the female students...No names of the guilty or accused parties were given. The class felt much better afterwards, but the boy who was doing the harassing took the whole thing as a joke...It made me realize how serious this issue can be even in the elementary school classroom."

University supervisor reflections

As university supervisors, we visited our student teachers on a regular basis once or twice a week to provide them with feedback on their classroom teaching skills. However, contact once a week between the student teacher and the university supervisor may not be sufficient to deal with some of the issues and circumstances that arise in a classroom setting on a daily basis.

Furthermore, due to other teaching, advising and additional university commitments and responsibilities, it is often difficult for a university supervisor to conveniently meet with their student teachers in a timely fashion to discuss, analyze, and debrief after a particularly stressful day in the classroom. Many university supervisors have recommended that their student teachers call them when they have immediate questions, comments, concerns, or problems regarding their students or their classrooms. Unfortunately, this often results in both parties playing "telephone tag" and spending more time trying to get a hold of one another than discussing the original problem.

Even though there were some technical obstacles to overcome (e.g., interference from local television stations, communication phone lines for the modems in schools), our project appeared to facilitate timely communication between student teachers and faculty members. Student teachers used the e-mail system to send words of encouragement to one another, ask other student teachers questions about appropriate curriculum for a given student, request more information about a given topic that they would later share with a parent or fellow colleague at their school, or to comment on their progress in student teaching. This communication system has fostered a great amount of self-efficacy and reflective thinking for student teachers and university faculty members.

University supervisors agreed that: (a) student teachers were more willing to ask how they might do things differently than they might have done otherwise; (b) student teachers were more able to consider alternative approaches to the handling of challenging situations; and (c) they were more likely to share their experiences with others and to benefit from being not only the giver, but also the receiver of information. Overall there also appeared to be a decrease of anxiety in student teaching, and an increase in confidence in the use of technology.

Implications

Our study is exploratory in nature. It provides the following implications for further studies.

Implications for utilizing educational technology in teacher education programs

Our study suggests that simply providing the modem and technical training for using e-mail is not sufficient. Students need systematic and intensive individualized support. The many factors constraining the use of e-mail should be removed.

The study indicated there were several technical difficulties that detracted from the use of e-mail for reflective thinking. The location of the computer and modem, training of the student teachers, and a very busy internship were the factors that constrained the use of e-mail for reflective thinking.

We found that most student teachers did not have a computer at home and thus needed access to a phone line and computer at the school where they were student teaching. Installation of the modem within the school was a major problem. A phone line needs to be close to a computer and available at times convenient for the student teacher's use. Because the phone is in great demand in most schools during the day, the student teachers were hesitant to tie up the phone while others waited to use it. For some this hesitancy was heightened by lack of confidence in the efficient use of the modem. It was difficult to find a quiet place where the student could use the modem for reflection without being disturbed.

One session was held on campus to train the student teachers to use the VAX commands for e-mail. However, the communication software they found on the school computer was different in almost every case from the software used in the training session. The software was not hard to learn for those who used the modem several times. However, the unfamiliarity of the software presented another factor that kept some student teachers from using the modem. It was easier for some to make a phone call, than to risk the extra time and inconvenience a modem message might entail.

The students joined the project because they were eager to have a modem to use during the time they were away from the University, from their peers, and in a new environment in which they wanted support. However, lack of time was a major reason given for not using the modem. The student teachers had so much work in planning and teaching that they were unable to use the modem for reflection. There were two students who had modems at home and yet were too busy to use them. The student teachers were overwhelmed with the demands of the field experience.

Implications for the design and implementation of a reflective teacher education program

Reflective thinking, however central to student teaching practice, is difficult for student teachers. The first reason is that reflective thinking is cognitive in nature. The ability to look back and learn from one's experiences within a classroom environment is extremely complex and difficult to acquire. A second reason is organizational in nature. Researchers have cited teachers' lack of time, insufficient insight and enthusiasm from school supervisors, omission of structured opportunities to reflect (Wedman, Martin, & Mahlios, 1990), and demanding work loads of university supervisors as affecting teacher reflection (Zeichner, K., & Liston, D., 1987).

The finding of our study indicated that in order to facilitate reflective thinking in student teachers, a teacher education program needs to (a) provide more direct guidelines on reflective thinking, (b) give more individual consultation, and (c) use all kinds of vehicles, especially educational technology to facilitate reflective thinking.

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Computer Conferencing, Moral Discussion, and Teacher Development

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Although it may be the moral and ethical dimensions of teaching that set it apart from other professions these issues are often ignored in preservice programs or given, at most, a passing mention (Goodlad, Soder and Sirotnik, 1990). Yet, as the population of students in the schools becomes more diverse, the moral dimensions of teaching become increasingly complex. As Taylor and Swartz (1991) point out:

> Major ethical issues seldom arise when a single monolithic worldview holds sway over what counts as legitimate knowledge. Ethical issues within a single worldview tend to be relatively trivial since they involve matters of style or interpretations of the cannon. Ethical questions are more likely to become central when competing world views clash over matters of substance and practice (p. 59).

If we acknowledge the need to help prospective teachers begin to deal with the issues they will be faced with as professionals in an ethical way, we must identify the specific experiences and methods that will help us do this more effectively than others. This means we must find ways to gauge our students' moral development, develop techniques that further foster that development, and assess their effectiveness. In this paper we examine if computer conferencing activities can be structured to support moral discourse, a key element in moral development.

Dialogue has long been valued as an educative experience (Burbules, 1993). In addition, discourse has been viewed as one of the chief methods of fostering moral development (Berkowitz, 1985; Kohlberg, 1984; Oser, 1986). Although there are a variety of ways to provide opportunities for discourse and dialogue such as class discussion and the case method, computer conferencing is a relatively new and, as yet, unstudied way to generate moral discourse. Indeed, computer conferencing has characteristics which may make it uniquely suited for doing so. Conferencing activities can be structured to support aspects of an ideal speech community, a necessary condition for optimal moral discourse and development according to scholars such as Habermas (1991), Oser (1986), and Strike and Soltis (1992). In addition, conferencing activities can be structured to encourage students to reason about other students' reasoning and, as Berkowitz and his colleagues have shown (e.g., Berkowitz, 1985), this may have a greater impact on students' moral development than stage disparity, previously identified as a key element in moral growth through dialogue. Although each of these goals is difficult to achieve in regular classrooms, they provide the necessary scaffolding for moral development and ethical decision making.

The Dialogical Community Exercise (DCE), the activity that provided the data for this analysis, was designed and structured to provide this scaffolding.[1] The exercise was a major component of one of the first courses students take after being accepted into the School of Education. The DCE was structured to encourage an ideal speech community. Students were provided with a comprehensive rational of the activity, participated anonymously, were free to enter into the conversation at their convenience, and were encouraged to address taken for granted assumptions they and other participants brought to the discussion. In this way we attempted to exchange norm-referenced expectations, share equally and reciprocally in the communicative process, and question the validity claims of statements — all components of an ideal speech community. Students were also provided with guidance and encouragement in questioning what others said in relation to their own perspectives on the issues addressed, indicating when they were in disagreement or agreement and why, and in seeking further clarification. In this way we hoped to increase their reasoning about others' reasoning. How effectively we were able to accomplish our goals will now be discussed. First we discuss our source of data, next we discuss our analytic framework. This is followed by a discussion of our findings and implications for further study.

Data Source

Twenty six students participated in the conference that provided the transcript for analysis. Nine individuals were nontraditional students — they had received degrees or had returned to school after an extended absence. The remaining 17 were traditional students — college juniors or seniors, 19 to 20 years old. Of the total, three students were male and three were minorities. The makeup of the class was comparable to other cohorts of elementary education students at the University. Our analyses focuses on two of the dialogues, referred to as Dialogue 1 and Dialogue 2, which occurred on the DCE.[2] The dialogues took place during separate weeks of the second half of the semester. There were 70 responses with all students participating in Dialogue 1. All but one of the students participated on Dialogue 2 and there were 76 responses. Each dialogue began with an "item" which described a dilemma a teacher might face in his or her professional life.[3] Both of the items were generated by the teaching assistant along with 2 or 3 students who were assigned the role of facilitators for that particular dialogue — each dialogue had a minimum of two student facilitators. In addition to writing the item, facilitators were required to facilitate the discussion which involved participating more often and trying to move the discussion forward.

Analytic Frames

In our attempt to explore if conferencing activities can be used to encourage moral discourse and, thereby, moral development we drew from two bodies of scholarship to structure our analytic frames. The first focused on the work of Berkowitz and his colleagues on the developmental nature of moral discussions (e.g., Berkowitz, Oser, & Althof, 1987). The second drew from Oser's (1991) work on moral discourse in which he has explored the professional morality of teachers. Each is discussed more fully below. As described previously, computer conferences are quite likely a unique medium through which student development can be fostered. In addition, computer conferences may also provide an opportunity for teacher educators to observe and monitor this development. The hope is that through exploratory investigations such as this, methods of gaining insight into students' growth through the use of computer conferences will be identified.

To determine if conferencing activities can help students reason about others' reasoning we drew from the work of Berkowitz and his colleagues to develop our first analytic frame. They found that individuals whose discourse exhibits transactive features, defined as "reasoning that operates on the reasoning of another" (Berkowitz & Gibbs, 1983, p. 402), during a discussion of moral dilemmas show gains on measures of moral reasoning. As indicated above, their work indicates that the use of transacts in discussions appears to have a larger impact on moral development than does moral reasoning stage disparity among the discussants. This is a particularly compelling finding because moral reasoning stage disparity has been traditionally thought to be the key factor in moral growth through dialogue. Berkowitz describes 18 types of transacts which fall under two general headings: representational transacts and operational transacts. Representational transacts are considered lower level in that they only represent the reasoning of another individual, but do not transform the reasoning in any way. Operational transacts, in contrast, involve a transformation of another's reasoning "via integration, logical analysis or some other operation" (Berkowitz, 1985, p. 205). In this study, the two dialogues were analyzed using their criteria. The analysis provided insight into the degree to which representational and operational transacts were incorporated in the responses made by the students to each of the two items.

A second level of exploratory analysis was completed drawing from Oser's (1991) work on the discourse approach to moral development. His work suggests that when making professional decisions, teachers attempt to coordinate care, justice, and truthfulness. While these three dimensions are not the only considerations teachers make when deciding on a course of action, these three dimensions define a teacher's ethos, or "the particular understanding of responsibility as a professional" (Oser, 1991, p. 203). Oser suggests that when given hypothetical education dilemmas, teachers balance these three dimensions using five different discourse approaches (from least responsible to most responsible): Avoiding, Delegating, Single Handed Decision Making, Incomplete Discourse (Discourse I), and Complete Discourse (Discourse II). In this study, both dialogues were analyzed by looking for evidence of students attempts to balance care, justice, and truthfulness. This was done to determine if conferencing activity are an effective method of providing these kinds of experiences to students. In addition, we analyzed the dialogues to determine if we could gain insight into students' approach to ethical decision making.

Findings

The analyses of Dialogue 1 and Dialogue 2 indicate that transactive discussion did take place during both of the dialogues. It was possible to identify comments and questions made by the students in which it appeared that they were reasoning about the reasoning of the other participants. Operational transacts seem to be twice as common as representational transacts; there were approximately 30 operational transacts in each of the dialogues and approximately 15 representational transacts. The analysis further indicates that transacts took place throughout the dialogue. In other words, at least for these two dialogues, there is no indication that transacts are more likely to take place during a specific section (e.g., the beginning) of the dialogue nor is there any indication from this analysis that there is a typical number of transacts per response. In many responses there were no transacts identified, but in some responses there could be as many as four transacts. The following comments taken from the conference transcript suggest the reasoning that students were doing about others' reasoning — the transactive nature of the dialogues.

> L 10: ...A lot of the responses mentioned grouping by ability, are these people aware of the negative side effects of this type of grouping? Another idea or thought that I've heard about from different students, which they took from the reading, is that reading is seen as something that comes naturally. Just as babies begin to walk and talk miraculously, so do children begin to read when they are ready. This kind of negates ability grouping.....

> L 3: As a consequentialist, I would also seriously consider the overall benefits of my decision. As L4 said that it may not be in the best interest of or benefit any of the other students besides the two who the teacher is sending to the camp. The other students may feel inferior compared to the two who were chosen to go. This decision may damage their self-esteem. For instance, they may think "Why wasn't I chosen to go?" But on the other hand, the information and the rich experience that the two children may gain could be shared with the other students in class and maybe extend the enjoyment of language arts to others.

> L 12: To L 22 and L 27: You misunderstood my point. My point was certainly not that 300 is a small amount of money. The point is that when we talk about the value of something, we must separate it from talk about the price of something. Price is still not what it "comes down to" when we say that people are equal.

An unexpected finding of this analysis was that the average number of transacts for those students who were assigned the role of facilitator was higher than the average number of transacts for the other participants. This result suggests that being a facilitator may increase the likelihood of making a comment with transactive features, a finding that demands further investigation in light of our interest in fostering the moral development of our students.

Our second analysis focused on whether the elementary education students were attempting to balance justice, care, and truthfulness as they struggled with the dilemmas presented to them on the DCE. The analysis indicates that students were, in fact, doing just that. As Oser's work has indicated, however, the students each balanced these three dimensions in different ways. The benefit of the DCE appeared to be that the students were exposed to the ways that the other participants coordinated these three dimensions. The result often was that the students modified their initial solution to the item when they understood the reasons behind other students' solutions, as some of the following comments indicate.

> L 15: ...Anyway, back to the situation with all of these mixed level students. I think that I would divide them up into ability-based groups, but not all the time. I would like to divide them so that students on the same level can read the same books and discuss with one another, answer questions, read for understanding, etc. However, I would be careful as to how I treated the groups or named them because I would not want students to feel that they were inferior or superior to other students, or to develop complexes about not being as good as someone else....

> L 22: ...I want to address the idea of ability grouping. I can see how some people feel that the negative effects are too great to have ability groups, but I think that groups of mixed abilities can also cause problems. I can remember when I was in elementary school and we had to get into groups and take turns reading. There were always kids that took forever to get through reading their paragraph and the rest of the group would always get restless and end up not paying attention and not listening. I think that students can sense when their fellow students are not paying attention and that may cause them to have negative feelings about reading aloud...

> L 14: In taking the consequentialist point of view, I would probably give Kasey and Dave the money. My reasons for doing this would be the following: First, I want to take into consideration how it would affect the two children. They both have incredible talent for the literary arts, and by sending them to this camp, they would be exposed to the subject in a more thorough environment. Realizing that their parents aren't able to pay, I come to the conclusion that someone has to provide the way to get them there. Their love for the subject would only be enhanced as a result of this camp. Consequently, the children would benefit greatly. I have to look at this also from the other children's point of view in the classroom. They are not able to go to the camp because of financial reasons as well, so is it fair to send Kasey and Dave (especially fund the trip) and not allow the other kids to go? Seeing this point of view makes it difficult to send the children to the literary camp. However, I feel if an explanation was needed to give the classmates, I would simply state their talent for writing and honestly give my reasoning for paying for the trip.

Although our analysis provided insight into how students attempted to balance care, justice, and truthfulness, it was very difficult to determine which discourse approach (e.g., avoiding) the students were using as they did so. This may be due to the fact that the nature of the computer conferencing task was different from that of the task that Oser has used (interviews with teachers). For example, on the DCE students often seem to be exploring possible courses of action they could take, rather than writing their solution. In addition, because this is a dialogue, the students solutions often change as they read what others suggest. It does seem fair to say that, in general, the students initially suggest what Oser (1991) would label Single Handed Decision Making — the teacher taking the problem into his or her own hands without justification. It is through the course of dialogue that students are prompted by the questions of their peers to justify their actions and possibly rethink their approach. A move to a Discourse I approach.

Discussion

Educational researchers have begun to acknowledge the moral dimension of teaching and, therefore, the crucial role teacher education must play in prospective teachers' moral development. Peer discussion has long been believed to be a, if not *the,* method of facilitating moral development. Computer conferencing is a way to encourage peer discussion of important educational issues in a non-dominated, nonthreatening way. The analyses done is this paper indicate that teacher educators can use computer conferencing to aid in understanding how students are thinking about the moral issues inherent in education.

Teacher educators can gain insight into the students' abilities to think about what others are thinking by looking for evidence of transacts in the students' responses. For example, teacher educators can note whether students are questioning others assumptions (as seen in some of the excerpts above). When students engage in this kind of reasoning, they are showing that they have carefully read and reflected on what another student has written and may, in turn, be fostering each others' moral development. In addition, by observing how students balance justice, care, and truthfulness in their responses we gain insight into their approach to ethical decision making. As is clear from the excerpts above, students are differentially concerned with these three dimensions, which results in different proposed solutions to the dilemmas presented.

This line of inquiry into the role of computer conferencing in teacher education needs to be further explored. While it may not be possible for teacher educators to analyze the responses of each preservice teacher, it is possible to use these two approaches as a lens through which to read the dialogue. In this way, it is possible to go beyond what students have written, and place their responses within the larger frame of moral development. As Oser (1991) claims, "teacher education doesn't do enough when it leaves out preparation for responsible solution of professional conflicts" (p. 224). By using the framework that has been presented here, computer conferencing can play a role not only in filling this gap, but in addition, allow teacher educators a way to better understand the thinking of their students.

Notes

1. See Harrington (1992) for an expanded discussion of the DCE.
2. Dialogue 1 took place when curriculum issues were being addressed in class. The item explained to the students that they had just been hired as a second grade teacher of 25 children with diverse cultural backgrounds. The children in the class were identified as having varying reading abilities as well (e.g., 4 spoke English as a second language, 1 did not know the alphabet, 2 read at the fourth grade level). The students were asked to discuss how they would approach reading instruction and meet the individual needs of the children. Dialogue 2 was entered onto the computer conference during the component of the course when professional ethics were addressed. This item asked students to think of themselves as a middle-class teacher teaching children from very low-income families. Two children in their class had exceptional talent and enthusiasm for language arts. The students were to consider whether, as teachers, they should pay for these two children to attend a camp that specialized in creative writing.
3. The DCE is made possible with Confer II ™, a computer conferencing system that operates on the University's IBM 3090 mainframe computer. See Rapaport (1991) for a further discussion of Confer.

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Internet Activities Open New Worlds for Educators

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Computer-mediated-communication (CMC) opens a world of information to students and educators alike. Telecommunicators may discover new ideas, discuss timely issues, and exchange limitless information for administrative and instructional purposes. As computers, modems, and other methods of connecting to the Internet become more readily available, teachers must learn to utilize these effectively as support for a wide variety of professional activities. This article discusses educational applications of telecommunications, and how Internet communications experiences are used in both undergraduate and graduate classes in two Colleges of Education..

Technology and Communications

We are now in what Hedrick (1993) calls "the third great revolution of humankind: the Information Revolution...during [which] knowledge will be the driving force of society, and measure of wealth will be access to that knowledge" (p. 14). To prepare our students to succeed, both in school and beyond, we must help them learn and develop skills that will allow them to access the information that surrounds us. Technology, one of the keys to information and retrieval, needs to be used as a tool, not as the focus of activities, as has previously occurred. Hedrick contrasts these two approaches—

> a Ptolemaic version of the world in which the technology was at the center and the user of that technology adjusted to the characteristics of the technology...[with]...a Copernican view, where the user is at the center, and the technology is used to assist the user. (p. 12)

Internet activities exemplify this latter view while promoting the exploration, location, and retrieval of information. As educators develop these skills, they discover a world of individuals and information waiting to provide help with every imaginable request for instructional, administrative, and personal purposes.

Connie Stout and Tracy LaQuey (1993), in an article that should be read by all K-12 educators, discuss advantages of and barriers to Internet communications. They explain, "Today the Internet directly connects with almost 50 countries and, through electronic mail, touches over 100. Encompassing more than 9,000 networks, it is expected to reach an estimated 20 million people over the next year" (p. 27). They also point out that despite the many different obstacles that interfere with Internet access "thousands of teachers and students make the journey [onto the Internet} every day" (p. 26).

With society's general acceptance of information technologies and their applications, educators must be prepared to function in what Barron and Ivers (1993) refer to as a "classroom without walls". The Office of Technology Assessment (1989) explains that, inevitably, " some [teachers] will teach on these systems, others will use them to provide additional resources in their classrooms, and many will receive professional education and training over them" (p.18). Colleges of Education must take the initiative to help their undergraduate preservice teachers, as well as their graduate students (who are often also full-time teachers) acquire and utilize information gathering skills that will open new worlds to all. However, special care must be taken to integrate Internet activities into the curricula of university classes, so that students learn to use the Internet for real, rather than contrived, purposes. As they discover the value of the Internet in their own lives, they will be more inclined to continue using it after completion of university classes.

Communications for Preservice Teachers

The demands on teachers entering the profession are great. "As preservice teachers leave their teacher preparation programs, they are often faced with the realities that school districts demand they use technology, parents expect them to use it and students want them to use it" (Novak and Berger, 1991, p. 89). Further, their function in the school has also changed. "Instructors do not always need to be the disseminators of the information, they must see themselves as the facilitators. They must be the ones that coordinate the body of knowledge from a variety of sources and assist the student in their use of that information" (Patten, 1990, p.19). The Internet application is obvious. Through effective use of this technology, teachers can provide unlimited sources of rich information in a learner-centered environment.

Likewise, the demands on teacher preparation institutions are also great. "Teacher educators have a professional responsibility to experiment systematically with applying existing and emerging technologies to teacher training if preservice teachers are to be successful in the 21st century" (Lowe, 1993, p. 674). What will guide this experimentation? The International Society for Technology in Education (ISTE), developed guidelines for educational computing and related technologies in teacher preparation programs which were later adopted by the National Council for Accreditation of Teacher Education (NCATE). The effective use of technology in the classroom is addressed, as well as communications and information resources (Thomas, 1991). Obviously, as the information *Superhighway* develops, programs which promote effective practices must develop simultaneously. Mountain (1993) explains, "Telecommunications networks are mushrooming, so teacher-education programs need to acquaint their students with the potentialities of the technology" (p. 43). She describes three different joint projects between teacher education programs and public school classrooms, where teachers and preservice teachers have an opportunity to acquire and develop telecommunications skills as they interact with each other. New Internet activities are being developed continuously.

At West Texas A&M University, communications activities have been integrated into EDX 201, "Introduction to Education", a one hour survey course offered one night a week for six weeks. Not a requirement for education majors, it is typically taken by students who are undeclared majors seeking more information about the profession. Because of the brevity of the class and the numerous field experiences built into other education courses, field experiences had not been a part of this course. To provide students with a taste of what is happening in the schools, *electronic fieldwork* (as described by Eskridge, 1993) was introduced. A call for participation was put out on the EDNET list, resulting in 17 responses. Students were then assigned a teacher, and correspondence began.

> Greetings Kyla:
> I am writing from Halifax, Nova Scotia and this morning I had to scrape the frost from the windshield of my car. I really hate that. Other than that, the weather is pretty good. Fall here is lovely. Cool mornings, colourful leaves and warm during the day. Sounds like a tourism ad???

Current issues in education were presented to the class by cooperative learning groups. Then, in a collaborative effort by the class, interview questions were compiled. Two issues discussed in the interviews are illustrated below:

> Kristi:
> I am delighted to be interviewed by you. Any further questions or correspondence will also be welcomed, as you have the need in the future.
> EVERY EXPERT WAS ONCE A BEGINNER
> I use cooperative learning a lot, whenever possible. Since many of my students are learning software, I use paired learning at the keyboard and most of my assignments in class involve some sort of collaboration in small groups. I especially like to use "jigsaw" learning groups, where each student researches one facet of a topic and as a group, they learn the "whole" topic.

> Dear Bart,
> I hope I have been of some help to you! Enjoy! Technology...[includes] computers, modems and telecommunicating, and of course we have television and radio. I am currently trying to inservice the teachers in my school about telecommunications. The students are writing hello letters to send to other places, in this manner, we are going to teach by example. Next year, we expect to introduce multimedia ideas. WE do a lot of Zap shots of events and add music to it and it becomes video productions.

Reactions to the interview answers were discussed, compared, and contrasted. Not only did students gain greater understanding of the various issues, but in many cases, realized what *inclusion* means in a real school.

Though the purpose of this project was to give students greater insights into education, it ultimately fostered student/student and student/instructor communications. Messages like this were common:

> Dear Mrs. McKinzie,
> I wanted to ask you if you could find out about the requirements for a special education teaching certificate

> to help me get a better idea of how many more classes are required in addition to the provisional general education requirements. I would appreciate any information that you could give me.

As the project was winding down, one of the corresponding teachers suggested we could gain further insights by communicating with his ninth grade students. We all thought that was a great idea and subsequently drafted an interview dealing with issues important to students today. The ninth grade students were very receptive and quite candid, providing the university students with an additional perspective on the use of telecommunications.

The activities described here only acquaint preservice educators with the power of the Internet. Hannafin and Savenye (1993) state that "many researchers attributed the failure of innovations to teachers' inability to adapt their teaching styles to maximize the potential of these innovations" (p.26). Obviously, teacher preparation institutions must also model integration of remote information sources into effective instructional practices to prepare preservice educators to facilitate classrooms in the information age.

Communications for Teachers/Grad Students

At East Texas State University, communications activities are included in all graduate educational computing courses. Students use e-mail, subscribe to and participate in discussions on lists, and find and download information through archie, gopher, and ftp. CMC activities have been integrated into all of these courses, to emphasize that the Internet is just one more tool to be utilized as an information gathering source, rather than an isolated experience.

A key element, utilized in all classes, is ETECESP, a list established for both current and former educational computing students, as well as for other interested individuals. This list gives students an opportunity to practice large-group online communication skills while discussing a variety of topics. Discussion topics are assigned to each class each week; each student must contribute to the group discussion, sending additional personal messages as desired. An unexpected bonus is the active involvement of non-class members in these discussions; former and current students do not hesitate to join in. A former student , after subscribing to the list, commented:

> Now I will feel the necessity to answer all those practitioners. :-) What a deal! When time allows, I can support the students and their efforts. I have responded to two tonight and will check daily.

Items from other lists are often forwarded to ETECESP by the instructor as well as other participants, providing a broader exposure to educational computing than would be possible in any one class.

Students learn to access and redistribute information to other students and colleagues, utilizing their Internet skills in other (noneducational computing) courses, and providing information (and help in obtaining it) to their classmates and friends. Copies of all communications during the class semester are sent to the instructor, who enjoys seeing the interaction between current and former students, as in the following:

> Actually, Dr. Espinoza did not assign this. It is for my facilities management class.

A former student had seen a current student's request for information to a list (not ETECESP), and had assumed that it was for an educational computing class, whereas it was actually for a class in the College of Business.

One problem encountered when students drive from distant locations to come to classes is that access to instructors is often limited to the student's time on campus. Telecommunications allows students and instructors to send messages (and responses) at any time. Topics range from specific questions about class assignments, to requests for help with specific software programs, to advisement for course scheduling and degree plans. After class one evening, a student sent the following:

> I tried to access my message to you on tenet dealing with the test question for the midterm, but I was unable to get to it!! You told me to go to "f" for folders and then type in sent-mail. After I typed in "f" and hit return, it would not allow me to type in sent-mail. I tried highlighting what was already there to see what I would get, and it just took me back to my message list! Help please. I really want to put that midterm answer in my portfolio.

This student found a return message, with complete instructions, waiting for her in her mailbox on TENET the next morning, and she was able to complete the desired task with little difficulty.

The university/public school connection has continued as these graduate students go back to their public school classrooms and use the Internet to obtain information, communicate with other educators, and provide learning experiences for their students. Ease of communication between the teachers and university faculty has facilitated conferencing about degree plans (masters and doctoral studies), course offerings, and a variety of educational issues. Messages forwarded to individuals and the list provide educators with information that can be *used on the job*. The following illustrates the results of one such message:

> As a result of your alert, my school district saved $3200 when we purchased our Mac Lab this year.

One reason for integrating communications into all of the educational computing classes is to help the graduate students develop information seeking skills that they will then be able to use in their schools, to help themselves and their colleagues. The following message illustrates how one former student is doing just that:

BEST COPY AVAILABLE

> I pulled a great deal from Scholastic for free software the other day, and sent off the request today. I love all this stuff. I also pulled a sample CNN lesson plan and sent that out to my teachers today. The decision is theirs, but they cannot say they were uninformed. Please know that I grew in the summer I spent with you. I didn't necessarily want to, but it has proved to be a great benefit.

Communications in the Classroom

A major obstacle to the use of communications in the schools is access to the Internet. A recent request for information on the electronic discussion list COSNDISC asked existing K-12/university partnerships, where K-12 schools have access to the Internet through universities. Numerous replies to the list (as of this writing) have revealed at least 15 partnerships, including one in Germany. In addition to Internet access, there must also be access to a modem and phone line. Although all K-12 educators in Texas are eligible to have Internet access through TENET, the Texas Education Network, many have no modem or phone line with which they do so. This was a major concern expressed by 32 administrators and administrative interns during their introduction to TENET in a graduate summer course. However, after they explored TENET, and discovered the wealth of information available, they were determined to gain access. Many were able to get modems into their schools, some into their offices, and a couple into some classrooms. One student, an assistant principal who had never heard of TENET before the class began, has even provided TENET training to teachers in her building this fall.

A student in another class began a correspondence with an individual who answered a request she sent to a list (based on a class assignment), leading to an exchange of messages between classes in Texas and Alaska. While thanking the Alaska teacher for his information, she asked,

> Would some of your kids like to talk to some of the children in the school where my son is? If you think that might be a possibility, let me know. Also, let me tell you where the school is and something about it

Another student contacted a former student who is now on scholarship in Italy.

> I got your letter (email) :-)
> It was great I captured the text and will print it out in hard copy form. This is great. I sent a carbon copy to my prof at E.T. I told her one my personal goals for the class, was to be able to communicate with you electronically from Italy. We did it!!
> Let me know the best way to reference the mail, so that the college knows it belongs to you. Congrats on networking across the Atlantic!!

Arrangements were made for this student to communicate with the students at his former school, bringing a bit of Europe to East Texas.

A teacher (who was also taking graduate courses) wanted a way to provide special multicultural experiences to students in a humanities class. She designed a project in which junior high students could communicate with international students in her graduate class. Her introductory message (below) was followed by contact between the two groups of students, with some fascinating questions from each group.

> This is an official welcome and I want to extend an invitation for you to participate in a telecommunications project with 8th grade humanities students from Cooper Junior High school.
> A group of three to four students would email question to each of you about your country and yourself. Ideally we would be communicating back and forth approximately two times a week. Your help in this project would be greatly appreciated..

A graduate student who is also a high school teacher sent the following message after TENET (the Texas Education Network) was introduced in the beginning educational computing class:

> I appreciate you allowing us to participate on tenet. I will be allowing my students to participate in sending messages to various schools and persons throughout the state and also internationally. I would appreciate any tip you could give me concerning student messages through my high school access.

This teacher and her students are now participating in the Santa project, a yearly telecommunications project where high school students write "Santa" letters responding to messages from younger students.

Yet another student wrote the author of a book she had just read, received an answer from him, and sent this response in reply:

> BIG SMILES WITH DIMPLES to you! Thank-you for such a quick acknowledgment of my inquiry about developing a gifted and talented unit based on [the author's book]. You have also made my day by letting me know you've got a new book on the way...I will look forward to reading it! If you need any free illustrations, I am also a tech illustrator in my other life... :-)
> Have fun in Australia. It's one of my favorite places...great scuba diving...if you watch out for the mean fish! :(

Conclusions

If we, in undergraduate and graduate teacher education programs, are to prepare teachers to take advantage of the many technological advances that can provide world-opening learning experiences for themselves and their students, it is essential that we provide training and follow-up activities that will facilitate the use of these technologies. As Connie Stout and Tracy LaQuey (1993) explain,

The Internet, a public network of networks … already connects some 10 million people in the United States and far beyond. And it is being touted as the best available networking infrastructure for the education community by people who use it, providers offering services in it, and officials who make policy concerning it. (p. 26)

This, then, is the challenge to our teacher education institutions—to provide opportunities for current and future educators to develop the skills that will allow them to use the Internet to open new worlds for to their students and themselves.

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Technology: Connecting People and Places

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University faculty in colleges of education typically seek out practitioners and enter classrooms only when they wish to find placements for preservice education majors needing exposures to children and teaching environments. Outside of student teaching experiences, communications between professors and classroom teachers is minimal. These interactions are "marriages of convenience" (Smith and Auger, 1986).

The educational landscape in public schools is constantly changing. Requirements for teachers have shifted and the science on effective teaching practices has expanded. Therefore, old teacher training paradigms must be broken. Teacher Education alternatives must be encouraged, planned and risks must be taken by universities and public schools if modern effective teacher training models are to be developed. Constructing a communication system that links practitioners and university faculty is one mechanism that may assist the change process. Contractual agreements that unite these parties can work if effective communications are established and if both parties realize benefits (Goodlad, 1987).

This paper will explain how the College of Education (COE) at the University of Northern Iowa (UNI) created collaborative partnerships with nine major school districts across the state of Iowa. Goals of these partnerships were to establish several different kinds of relationships between practitioners and university faculty. Multiple relationships were built, but my remarks in this manuscript will focus on the computer network enacted and the conclusions that were significant.

The Challenge

In the fall of 1988 the new Dean in the COE at UNI challenged the faculty of the Office of Student Field Experiences (OSFE) to establish collaborative partnership agreements with the school districts where UNI student teachers were placed. Nine regional centers were identified. The Dean's vision was to create projects that would cause practitioners to become active partners in the UNI Teacher Education program. He wanted some umbrella activities that all centers could put into practice, but he was also open to project ideas that were center specific.

Projects

A computer conference system called Caucus was already functioning in the university community in 1988. It was new, but growing. The first umbrella project was to expand Caucus to the off-campus centers. To implement the project a modem equipped portable computer was linked to the main frame computer on campus through a watts telephone line. Professors who were Resident Coordinators of the off-campus centers, were trained to use Caucus. They were then charged with the responsibility to inform and train personnel in their respective centers. For the first time all centers could participate in computer conferences as well as send and receive private messages. Personnel in centers 250 miles from campus and as far as 400 miles apart could communicate with most offices on campus and with each other. No longer was "phone tag" a game Coordinators, practitioners and student teachers were playing.

A new dimension was added to Caucus. Field based personnel were sending messages, asking questions and adding responses to conference discussions. Practitioners and professors on campus were having frequent dialogue. The practitioners valued the collaborative interaction, and they were in positions to do something with the ideas exchanged.

To expand practitioner participation in center operations during 1989-1991 each Coordinator assembled a Cadre of teachers and employed a Clinical Supervisor(s) to work part-time with the Coordinator. Cadre memberships varied from 5 to 27 members and Clinical Supervisors ranged from 0 to 3 professionals. Approximately $17,000 was needed per center to achieve this second project. A sum of $2500 was allocated to each Coordinator to support and foster Cadre activities and $14,500 was used to purchase a percentage of a Clinical Supervisor's contract. In the centers these monies purchased between 30% and 50% of the Clinical Supervisors contract. This new organizational pattern may best be rationalized by Charles Handy in his interview with Edgerton (1993) where he explained his "Upside-Down Thinking" philosophy. To be a more effective organization, Handy suggests you reduce the professional core (Professors) and increase the subcontractors (Clinical Supervisors) and independent contractors (Cadre members). Handy's point was that some jobs are short-term so you hire part-time personnel to work until the job is complete. You do not employ more tenure track people for these positions. COE salary savings, an Iowa Department of Education grant for $108,000 and soft monies from the UNI President's office created the monies needed for this project.

Throughout the 1990-1991 academic year a third project unfolded. Coordinators, Cadre members and Clinical supervisors collaborated on center-specific projects. They created newsletters, established mentor programs for student teachers, organized seminars and local educational programs and they became familiar with Caucus and the Teacher Education program at UNI. Off-campus center progress was reported by the Coordinator and Clinical Supervisor through various conferences on Caucus. Caucus network users on and off-campus were aware of all center-specific projects. Ideas initiated in one center soon spread to other centers.

In the Spring of 1991 a Cadre Conference was held on campus. Campus faculty and off-campus cadre members had personal interactions. Alliances formed that resulted in joint efforts, e.g. subject matter practitioners advised method's faculty, professors came to Cadre member's classrooms to see firsthand what student teachers were experiencing and research projects were initiated.

It was apparent more collaboration was needed and desired. For the 1992-1993 school calendars a fourth project's goal was to obtain modem equipped computers for all Cadre members. Today there are 125 computers off-campus. A grant from IBM facilitated this process. Practitioners are currently involved in 91 different conferences on the Caucus network. Some conferences have public access, some are special interest groups and some are restricted. Practitioners use the network to serve on University committees, to help plan conferences in specific subject areas, to exchange ideas on effective teaching practices and to participate in research activities. Practitioners have presented papers with UNI faculty at Association of Teacher Educators, Association of Supervision and Curriculum Development and at other national conferences.

Future Projects

The current networking system has brought practitioners, faculty, student teachers and administrators into daily interactions that would not be possible through traditional lines of communications. The "culture" of the UNI conference network is still evolving. The ability to conference has brought the Dean's original vision from being intangible to being noticeable and usable.

Currently the nine center Coordinators and the Clinical Supervisors are making the transition from Caucus to the Internet service. This transition will allow access to library data base files, E-mail, telnet capabilities, statistical and research services, and it will continue participation in established network conferences. The Coordinators and Clinical Supervisors will train personnel in the center so they can also use these expanded services.

Joining the Iowa Communications Network (ICN), the state's fiber optics transmission system, is a desirable extension for the collaborative partnerships. The interactive nature of fiber optics will allow teachers to conduct classes and then dialogue about teaching techniques with students in method's classes on campus. Bridging the gap between theory and practice will benefit Teacher Education at UNI (Yates, 1993). Inservice programs, graduate classes and innovative creations by off-campus teachers are feasible through this medium. The possibilities are excellent because there are 103 transmission sites, plus a portable unit operated by UNI.

Active network participants develop routines unique to their own needs. Most users want and need a hard copy of conference dialogues so they can ponder issues before they respond. To facilitate this need a grant committee has been appointed to find ways for UNI to purchase printers for each computer we have in the off-campus locations. Students pay $40 per semester as a computer fee. An argument for using some of these monies off-campus should be formulated.

Conclusions

The ability to connect campus faculty to field practitioners has positively effected the Teacher Education program at UNI. Classroom teachers have been a valuable resource to teacher trainees and student teachers, they have influenced university committee decisions, they have impacted curriculum content in method's classes and the rapport between faculty and teachers has been elevated (Stahlhut, Hawkes, Frudden, Davis, 1990).

I have observed that when faculty and classroom teachers talk about a specific topic in which they both have interest, e.g. mentoring student teachers, teacher trainee curriculum and collaborative action research, the traditional barriers between them disappear. Canning and Swift (1992) agree that "Once each member develops a self-concept of having a niche in the enterprise that is his/her own and that is valued, discussions engender full participation and take on a democratic tone" (p. 27).

Student teachers probably realized the most benefit from this network. When you student teach the norm is to ask for all the help you can get. Student teachers frequently communicated with network users in and outside of the center where they were assigned. They asked for ideas on discipline techniques, resource materials for units and about action research projects. Student teachers came to the centers with network knowledge and experience. They believed it was a natural extension for them to continue using the network during their clinical field experience. Because they used Caucus their cooperating teacher's interest in it increased. Hence, the student teachers helped practitioners become more comfortable with this communication system.

Written communications can be misinterpreted. Network users tended to paraphrase, write brief text, use abbreviations and could not incorporate visuals to add clarity to their comments. Often the tone of an individual's point could not be easily decoded. As users gained experience they found subtle ways to increase understandings of their communications, e.g. *emphasis* and :> for a smile. They also learned network etiquette, e.g. tolerance for spelling and grammar and not to respond in haste to a conference entry they could not support. Once words were printed they could only be erased by the conference organizer or Caucus manager.

General conferences designed for public forums were least successful. Without specific tasks, concerns or timelines participants from the field soon stopped making comments. Professors continued to pontificate, often expressing knowledge they believe to be the *truth* (:>).

One unsolvable problem has been the unwillingness of schools to provide a dedicated telephone line to the modem equipped computers UNI supplied. As a result, in many situations only the cadre member in each building actually has access to the network. Cadre members have based the computer in their homes. Until a greater variety of services are available on the network, e.g. entrance into library data bases, printer access or the possibility of pupils in the public school classrooms being given network passwords, administrators will not allocate funds to support the network.

Lack of administrative cooperation may have been a blessing in disguise. With the computers at home, cadre members said they had time to learn the mechanics of the communication system. They reported having them at home has been fun and professionally enriching. Had the computer been at school they would not have had time to "tinker" with them. Cadre members have gained knowledge from being part of the Caucus system and have verbalized this to their colleagues. Interest for getting the computers into the schools has generally increased among the faculty. Schools that incorporate the leadership plan known as site-based decision making tend to be more interested in getting the computers into the schools than do buildings that are managed by conventional administrators.

Summary

There are some definite factors that will contribute to a computer network becoming successful. First, keep technical information simple. Practitioners are alienated by computer jargon. Most teachers are novices at using computer conferences. They want technical assistance, so creating a "User's Guide" that explains procedures and commands has to be user friendly. Having a telephone "hot line" consultant available from 4:00 pm - 8:00 pm who can provide help will also reduce user anxieties.

Secondly, there must be leadership and commitment. Someone must facilitate user needs, e.g. getting new users registered with passwords and similar routines, making announcements or establishing a newsletter to update users about available network services, this person must monitor conference interactions, he/she needs to encourage the formation of new conferences and this individual must see to it that equipment is repaired promptly.

Thirdly, finding ways to bring off-campus and on campus professionals together so face-to-face conversations are possible builds rapport. Both parties want to know with whom they are conversing. Having colloquiums that are hosted by the COE Dean and jointly planned by off-campus and on campus personnel lets all the parties know how important and valuable they are to making the network a success.

Computer conferencing will encourage the exchange of knowledge, ideas and opinions. But only if and when users want to implement change will change occur. Computer conferencing will not propagate change, but it can promote it.

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TELECOMMUNICATIONS 2

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"Predictions are always difficult, especially about the future" - Neils Bohr, 1885-1962

Everywhere one turns today, there is talk of an information revolution taking place. New technologies are going to offer us links to the, "Information Superhighway," the "National Data Highway," the "Electronic Frontier," to "CyberSpace," and beyond. This message is being announced almost daily on the front pages of our newspapers, on the covers of our magazines, and on the airwaves of our nightly newscasts. They tell us that computer technology and communications are going to merge to change not only the way we gather and disseminate information, but our very lives. And the interesting thing is that for the most part, these messages are correct. Usually, however, what is left out of the message is that the information revolution is not only coming, for many of us in education, it is already here. Telecommunications is already playing a large role in many teacher education programs where faculty members and their students have been traveling the electronic information highway for several years.

Predicting the future of telecommunications in education is already beginning to become easier than it once was. Even if it appears somewhat fuzzy and out of focus, we can see an outline of where we will be as the information revolution proceeds. Currently, we struggle with such issues as downloading binary files over a modem, accessing an anonymous ftp server to retrieve a software file, or being able to share a formatted word processing documents with our colleagues across the country. Even being able to get phone lines into classrooms has been a major obstacle. But these inconveniences are not going to last.

Prediction Number One: Information distribution via computer networks will become simple, quick, and reliable. Within a relatively short period of time, i.e., the next few years, technology will advance so that any computer file, text, sound, photo, or hypermedia, will be easily transferable from one location to another. This is not such a bold prediction since this can already be done at many colleges and universities. The prediction, however, includes the notion that transfer of any type of file from one computer to another, will become as simple and as common as sending a fax or using a cellular telephone. Easy-to-operate user interfaces and high bandwidth connections will make reliable electronic transfer of journal articles, software applications, sound recordings, and video a normal way of life, even for the "technophobic" among us. That is not to say that computer networks will become simpler. Networking will by necessity become more complicated, but to the user, this technology will become simpler to operate. This will have major implications for the field of education.

Prediction Number Two: People will be able to connect to their computers from any location. Already, many of us connect to computer networks from our offices, our classrooms, and our homes. With the advent of notebook computers, we also connect when traveling and on vacation. Some of us use intricate maneuvers to access our office computers when we are not at work, with varying degrees of success. As the information revolution continues, we will be able to establish network links wherever we are, whenever we choose. People will begin to expect network connections wherever they go, and the way we think about computers will change from a tool we sometimes use to a commonly accepted part of our lifestyles. Fiber optic, ISDN, and HDTV connections will rapidly connect schools, homes, and businesses, and service providers and policy makers will begin to cooperate to insure that all segments of society have access to information networks. We are already beginning to see this in Texas with the recent appearance of reduced telephone rates for educational institutions.

Prediction Number Three: New telecommunications resources will alter our social and cultural interactions. This includes the delivery of educational material. As the information revolution continues, we will increasingly be conducting more of the business of daily life using telecommunications resources. Shopping, banking, voting, and being entertained via an electronic connection to a computer network will be commonplace along with hundreds of other possibilities just now being contemplated. The implications of the information revolution for education are likewise, just being discussed and developed.

These predictions are an attempt to understand how technology affects our lives and to begin focusing on the many changes in store for us as educators and members of an information society. Similarly, the articles in this section help us understand where telecommunications use in education stands today and where it is headed in the future. It is appropriate that the first paper in this section is Jean Casey and Mary Ellen Vogt's, *TeacherNet: The Wave of the Future...Toward a National Network of Educators.* The article describes TeacherNet, a program developed at California State University, Long Beach to research the effectiveness of using telecommunications to improve support and communications between university supervisors and student teachers. The paper reports project accomplishments and discusses future needs for technology in teacher education.

In his paper, Larry Albertson describes the University of Wisconsin-River Falls' global vision for teacher education which includes telecommunications projects with teachers and students in Russia, a curriculum development project composed of K-12 teachers and university faculty working with colleagues worldwide, and a visiting teacher program for teachers in 30 foreign countries.

Catherine Collier at UMass Lowell describes a graduate education course *Advanced Educational Technology Applications: Internet,* and discusses experience with three alternative approaches to Internet training designed to take educators beyond basic skills and to foster regular use of the Internet. The three approaches: Design of Projects for Application of Internet to the Curriculum, Focus on Internet Resources for K-12 Subject Areas, and Use of Internet in Support of Educational Research are part of a wealth of information about the structure and presentation of a telecomputing course.

Andria Troutman and Lara Kiser report on the implementation of the Learn From A Distance (LFAD) Program at the University of South Florida. LFAD is one of the ways in which the college is responding to the challenge of reinventing the curriculum through the use of technology, to build new programs for new constituents, and to find flexible delivery systems for expanding populations with unique needs. The long term goal of LFAD is to use technology to provide unique curriculum experiences for populations having diverse needs while exploring alternative methods of delivering instruction.

The next four papers describe telecomputing activities at the University of Virginia. Bernard Robin summarizes a research study related to Virginia's Public Education Network (Virginia's PEN). The paper details strategies conference moderators can employ to increase participation in online projects. Marguerite Mason describes her efforts in developing the Problem Solving Corner on Virginia's PEN. This effective online resource brings together K-12 students, their teachers, preservice teachers, and graduate students in mathematics education as an electronic community of learners focusing on problem solving. Marie Leavitt writes about an alternative method for storing information generated during electronic discussions on Virginia's PEN. The purpose of the *Jefferson By Topic* project is to examine and implement an approach to archiving online information. In *Utilizing Gopher Technology in an Academic Environment,* Cynthia Addison describes one of a series of concurrent efforts taking place at the University of Virginia. This article reports on an effort designed to provide academic and technological leaders with exposure to the expanding range of gopher technologies.

Presenting science education over a distance is the subject of William Boone's paper which describes a semester-long, fully interactive hands-on science course for elementary teachers. The class employed two-way audio and video between a studio at Indiana University-Bloomington and three urban elementary schools in Indianapolis over 60 miles away. Boone reports on the results of student attitudes toward the technology as well as discussing issues related to the delivery of this type of instruction.

Gail Carmack's *Project MentorNet,* describes the development and implementation of a project at the Science Academy of Austin which attempts to involve community members as online mentors for tenth grade biology students. Students use Internet resources such as Gopher, Veronica, ftp, and telnet to gather current background information on a research topic and then begin a series of online interactions with their mentors. Research projects are evaluated by students, mentors, and teachers and anonymously posted in a newsgroup for peer review, where other students are invited to read the papers online and to comment on the research.

The last article in the section is Steven Purcell's description of PBS Learning Link, a public television sponsored, computer-based telecommunications and information network developed for K-12 teachers. The project focuses on how educators can apply technology resources to enhance classroom instruction. At the same time, Learning Link attempts to devlop "transparent" technology, a trend that is certain to increase as more technological resources become available to teachers in all content areas.

As Mr. Bohr has stated, predicting the future is always difficult. As we move into the future, there is no doubt unanticipated innovations will occur and alter our perception and understanding of uses of technology in society. However, these articles certainly provide us with the foundation upon which we will continue to define the role of technology in education.

TeacherNet: The Wave of the Future...Toward a National Network of Educators

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As this paper is written, ten newly credentialed teachers are reluctantly returning the notebook computers they had at home during their sixteen weeks of teacher training. They all started as technology neophytes and finished their assignment as skilled technology users. They have had daily access to Internet and bulletin boards, the libraries of the world, and 12,000 other California teacher educators during their student teaching. This group brings the number we have trained in TeacherNet to over 200 people now using e-mail and conferencing to enhance their teaching.

TeacherNet, a program developed at California State University, Long Beach in 1989, has piloted and researched the effectiveness of using telecommunications to improve support and communications between university supervisors and student teachers. The purpose of this paper is to report project accomplishments and discuss future needs for technology in teacher education.

Background

In 1984, the Curry School of Education at the University of Virginia, under the leadership of Glen Bull created the Teacher-LINK system to connect student teachers with their university professors and improve communications among inservice and preservice teachers. Katherine Merseth launched her Beginning Teacher Communications Network (BCTN), at Harvard in 1987 to provide electronic support to beginning teachers during their critical first year. In 1989, TeacherNet was created at California State University by Jean Casey in order to improve the student teacher experience, increase the interaction between faculty and students, and enrich the quality of supervision and support. In these past nine years, we have learned a great deal about the efficacy of using telecommunications for support.

Why is it important that they have this increased support and access to information resources during their student teaching experience?

First, student teaching has consistently been identified as the most significant element in the teacher preparation process (Guyton and McIntyre, 1990). As preservice teachers apply theory to practice in this intense and prolonged experience, all previous knowledge and skills are synthesized and applied. It is assumed that this immersion prepares new teachers for the realities of the classroom. Yet nationally, new teacher retention is a serious problem: 15% of new teachers leave the profession by the end of the first year with another 25% leaving during the first three years.

Current efforts in increasing support for new teachers focus on the "teacher-induction" period of the first three years of teaching (Merseth, 1990). Other research has concentrated on the use of telecommunications as a means of providing support for preservice teachers (Bull, Harris, Lloyd, Short, 1989). Whether telecommunications support decreases new teacher attrition is unknown at this time. However, electronic networking between preservice teachers, university supervisors, and beginning teachers appears to enhance the student teaching and induction period experiences (Bull, Harris, Lloyd, Short, 1989, Casey, 1989, Casey & Roth, 1992, Merseth, 1990, McIntyre &

Tlusty, 1993).

At present, the nature and quality of this support is being investigated by the authors through the analysis of the e-mail communications of two cohorts of preservice teachers over two semesters of student teaching. Clearly evident from initial, qualitative data analysis is the improved quality of the student teaching experience, greater reflectivity on the part of the preservice teachers, and their greater comfort and expertise with technology.

Strengths of Telecommunication Programs During Student Teaching

Through the use of telecommunications during student teaching, the following benefits have been reported:

1. Increased reflectivity. Students in all studies reported increased time to reflect on what they were learning, including teaching approaches and decision making. Use of e-mail writing helped foster probing to promote deep understanding of teaching, to engage in a written conversation about experiences associated with their making meaning of teaching. (McIntyre and Tlusty, 1993 p.18)
2. Increased feeling of rapport with and support from the university supervisor, access to other supervisors and university personnel.
3. Increased team support, decreased feelings of isolation. Perhaps the most notable outcome of the e-mail approach is the immediacy with which students can establish contact with the university supervisor or their peers or master teacher. No longer do they have to call for an appointment or wait until the next seminar class to address concerns, questions, or ideas. (Moore, 1993)
4. Increased self-esteem due to mastering technology and receiving positive support through e-mail messages, increased pride from the professional documents they could create at home.
5. Increased knowledge and use of information access and retrieval as well as various types of technology, such as multimedia.
6. Increased use of the computer at home for personal and professional work and in the classroom when teaching.

Clearly, certain aspects of support that are enhanced by on-site collaboration cannot be reproduced by an electronic network. Compassionate looks, deep sighs, and other forms of "body language" that often help to tell a more complete story do not translate well on a computer screen. On the other hand, the network offers an at-distance forum where beginning teachers can discuss "problems" they encounter in their daily work (Merseth, 1989). The fact that the network is available 24 hours a day is a strength only this technology can offer, and when combined with good on-site support greatly improves the quality of supervision in teacher training.

Problems of Implementation

Through the use of telecommunications during student teaching, the following problems have been reported:

1. "Down times" of the network, when software is being replaced or a bug has been discovered in the system, are major deterrents once the students have become accustomed to this method of communication.
2. Access to computer equipment. At the University of Wisconsin where electronic mail was used for student teacher dialogue journals, one of the limitations in this study was the availability of computers, with only one computer-modem unit at each school. The researchers reported students were often frustrated with in-school access to the system. At California State University, Long Beach, students are loaned computers and modems to have in their homes and this greatly increased reflection and communication. The problem here is the number of computers available. With 200 student teachers and only 15 available computers the program's positive effect is limited to a chosen few.
3. Even if external funding is obtained for more computer equipment, the rapidity with which the equipment becomes obsolete is a major problem.
4. Storage and checkout procedures have been a problem in the past. However, recently surveyed CSULB teacher credential candidates indicate 80% of them have their own computers. This makes the future look bright with the possibility of expanding our TeacherNet to include all candidates we train by simply providing modems, public domain software, and training on use of the network.

Transition to classrooms

A critical question posed in early research was, "Will teachers trained with e-mail access at home become computer using educators in their classrooms?" (Casey, 1989). In order to facilitate this transition into the classroom this past semester, student teachers were required to bring a computer with a talking word processor into their classroom, demonstrate its use and use it with their students. By the time these student teachers completed the program they were skilled Internet users and were aware of how to access information and collegial support through technologies for their school and personal needs. Finally, they had introduced the technology to their own elementary or secondary students in the classroom thus proving their own expertise with the technology. These student teachers were all eager to have telecommunications in their own classrooms. Future longitudinal studies should report if this is a lasting effect.

Conclusions and Implications

Presently we have been using e-mail for five years. Ten semester groups of student teachers have participated in the TeacherNet program. Jean Casey is presently conducting a survey of these groups to determine the long term effect of telecommunications training during student teaching. The fostering of a community of professionals among preservice and inservice teachers has continued to be one of the prime outcomes. In California the original network had 300 educators online; today, the Computer On-line Resources in Education (CORE) has over 12,000 educators. It is presently being converted to a new Graphical User Interface

Designed for Education (GUIDE). This new software will improve the ease of use of the system. It is being developed by the California Technology Project.

The Future of Telecommunications Networks in Schools

Current government interest in the National Information Infrastructure Act, (Boucher,1993) and the Technology for Education Act, (Bingaman, Kennedy, Cochran, Harkin,1993) highlight the importance of training educators to become leaders in developing a coordinated national network and producing models for integrated technology use in the classroom. In the development of a national network, educational functions and needs should be addressed by educators. The graduates of TeacherNet, Teacher-LINK, BCTN and similar programs across the nation are trained and ready to accept this challenge. We, as teacher educators must continue through our leadership to expand and improve our programs and make sure that we play a significant role in the national policy decisions being made at this time.

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Technology Supported Teacher Education: Implementing a Global Vision

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My colleagues and I at the University of Wisconsin-River Falls share a vision for teacher education that focuses on quality, visionary leadership, collaborations, diversity, community, intellectual growth and the total well-being of the individual. The goal is to prepare ethical, reflective practitioners who are empowered to provide visionary leadership to the profession. Program characteristics include collaborative field-based experiences, a campus-wide commitment to teacher education, instructional technologies and intensive regional, national and international telecommunications-supported collaborations.

This vision differs from our current program and many other teacher education programs in our definitions of several of the concepts — redefinitions made possible by advances in technology. Perhaps this is best explained with examples of how certain program elements would function.

Collaborations would take on a more significant and powerful meaning than generally imagined, much less practiced. First, the notion of teacher education faculty would broaden to include selected teacher educators, master public school teachers and arts and sciences faculty committed to teacher education from all over the world. While each would come from a different background, each would respect and value others as equally important and necessary contributors. The roles of each in preparing teachers would be blurred. University faculty would be in K-12 schools teaching children while K-12 teachers would be on campus teaching university classes. Through technology a university class in Wisconsin might observe their professor teaching a class of young children in another country while the visiting teacher from that country discusses the approach to education being taken. All of the newly defined faculty would be comfortable teaching university classes as well as K-12 classrooms in rural areas, urban areas, and foreign countries or using contemporary technologies to interact with multiple audiences around the globe. Through modeling, faculty would teach aspiring teachers that teaching is a profession in which colleagues worldwide utilize telecommunications to work collectively, talk about their experiences and learn from each other.

Utilizing telecommunications these faculty, along with teacher education students, would simultaneously engage in the study of the learning and teaching process. Applied research projects would be an ongoing activity that invigorates the K-12 schools and the university. Collaboratively these faculty would share, through publications and presentations including electronic journals and bulletin boards, the results of their work and apply it to improve their practices.

Technology Supported Projects

Ways in which we use technology to support activities at the University of Wisconsin-River Falls that move us toward this vision of a telecommunications supported, global teacher education program include the following:

Telecommunications Project

Twenty-five K-12 teachers from our area and their classrooms are linked with teachers and students in Russia.

Using e-mail through an 800 number at the university, the participating U. S. classrooms have jointly completed projects with their matched classrooms in Russia that have included collaborative newsletter writing assignments, cooperatively written creative stories, language exchange, comparative physics experiments, general science projects, children's opera using folk tales and social studies activities. The linkages with Russia began four years ago, and several student and teacher exchanges and visits have occurred from both countries. We are adding other countries to the project and expanding to three- and four-way linkages.

Curriculum Development Project

Funded by Ameritech, the focus of this project is to develop curriculum materials that will empower K-12 teachers to implement telecommunications-supported project-based learning to enhance higher level thinking skills. We are developing a coordinated teacher preparation curriculum that will teach preservice and inservice teachers to implement telecommunications projects using the K-12 curriculum. We are establishing a technology support center on the River Falls campus to support teachers using the curriculum. The project team is composed of K-12 teachers and university faculty working with colleagues worldwide in telecommunications projects.

Kaliningrad Collaboration

An exchange project with Kaliningrad, Russia that is increasingly relying on technology has resulted in widespread regional support because of exciting outcomes such as the following:

- Three visits to Russia by a total of 71 River Falls area professors, K-12 teachers and K-12 students including a behind-the-scenes look at the technology of the Space Centre in Kaliningrad.
- Three visits to our region by a total of 109 Russian business and civic leaders, K-12 administrators, teachers and students.
- Meetings of Wisconsin and Minnesota businesses with Russian business and civic leaders focusing on computer technology.
- Follow-up trips by several businesses to Russia.
- An exchange of over 100 educational computer programs.
- Linking of several Kaliningrad teachers with our telecommunications project.

Visiting Teacher Program

This program coordinates summer teaching opportunities for teachers in 30 foreign countries. Last year 50 teachers were placed in 18 countries. Overall over 1100 teachers have been placed in 30 countries. Technology has greatly enhanced the quality of support and follow-up for this program.

Overseas Student Teaching

This program, which is supported by telecommunications, provides overseas student teaching experiences for students. Last year 24 students were placed in eight countries. Overall 720 student teachers have been placed in ten countries.

Course Infusion

To assure technological literacy on the part of our students we have developed an infusion model whereby the appropriate use of instructional technologies is incorporated into the entire sequence of the educational curriculum from educational psychology to methods and student teaching. We have been making progress in this infusion for the past three years. This year ten faculty members are engaged in special projects and development activities that will result in technology infusion in more than twelve courses and in collaborative projects with other professors or K-12 teachers.

New Directions

New projects recently initiated or in development include the following:

Telecommunications Supported Distance Education Courses

Faculty from UW-River Falls and UW-Stout will collaboratively develop a teleconference course with a primary delivery of one-way video/two-way audio also supported by other telecommunications and print media including Wondernet, audiographics, electronic mail, electronic bulletin boards, and international networks. The specific supporting media will be selected by the team based on student learning styles, available technologies and instructor preferences. Ongoing support that includes electronic mail and bulletin boards and electronic databases such as Peacenet and Delphi is being established. Based on their experiences, this team will then develop a teleconference course to teach faculty and K-12 teachers to develop telecommunications supported teleconference courses.

Faculty/K-12 Teacher Collaborative Projects

Faculty members who have identified specific projects they would like to pursue with a K-12 colleague are linked with teachers who express an interest in a faculty member's project.

Restructuring Classrooms With Technology

We are preparing to offer a conference and courses that focus on restructuring classrooms and schools using technology to globalize and expand the resources available to the classroom teacher.

Faculty and K-12 Teacher Inservice Plan

Because of the demand and varying levels of technology expertise we have developed a plan to provide inservice education opportunities for our faculty and K-12 teachers. One important aspect of this plan is the servicing of both groups with the same activities to continue our efforts toward increasing collegiality, collaboration and shared responsibility among university faculty and K-12 teachers.

Support For Technology Based Projects

Resources to support the escalating interest in technology by faculty and K-12 teachers continues to be a major problem. Much of what has taken place to date is due to the commitment and work of some dedicated individuals and to the sharing of responsibilities and resources among many K-

12 school districts and the university as well as our overseas colleagues. On campus we have used reallocations and grants to provide minimal support. As we work to secure additional resources, I have to pause and take great pride in my colleagues who have done and continue to do so much with such limited support.

Current and future changes in technology and an increasing receptivity to using technology will offer us numerous opportunities to move toward this vision of a technology supported global teacher education program.

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Beyond Telnet: Approaches to Internet Training for Teachers

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During the winter and spring of 1993, teachers and educational researchers in eastern Massachusetts enrolled in a variety of basic-skills workshops on Internet. Electronic mail, Telnet, and FTP training did not completely meet the needs for educators. Participants were frustrated by primitive interfaces, inconsistent responses, and non-robust services. Educators who persisted in using Internet became interested in integrating the resources and the communications medium into the curriculum. They looked for further opportunities for training and expressed interest in collaborating with other educators to enhance their Internet experience.

In the summer of 1993, University of Massachusetts at Lowell (UML) offered a 3-credit graduate education course "Advanced Educational Technology Applications: Internet" (03.654). The experience gave rise to other Internet workshops and classes, specifically for educators, to integrate Internet with the curriculum and to use Internet in support of educational research. This paper discusses experience with three alternative approaches to Internet training, all of them designed to take educators beyond basic skills and to foster regular use of Internet. The three approaches were:

- Design of projects for application of Internet to the curriculum
- Focus on Internet resources for K-12 subject areas
- Use of Internet in support of educational research

The three types of Internet training were implemented through University of Massachusetts Lowell (UML) and the Merrimack Education Center (MEC) during the Summer and Fall of 1993. Participants included classroom teachers from elementary, secondary, and higher education; library/media specialists; computer coordinators; technology consultants; and preservice teachers.

Strengths and weaknesses of each approach are discussed, along with plans for new and improved training. Central themes are how the training helped inexperienced users deal with the unfriendliness of Internet; teacher response to the wealth of material on Internet; involving teachers with Internet in support of their professional role; and striking a balance between realistic assessment of the difficulties surrounding student use of Internet and excitement about the benefits to the curriculum.

Project-focus Training

The 3-credit graduate course "Advanced Educational Technology Applications: the Internet" (03.654) was designed by Professor John LeBaron to expose students to Internet resources, to develop skills for Internet navigation, to promote collaborative use of networking by educators, and to develop a project that integrated the Internet with the curriculum. Projects could be designed to support teachers or other staff or to be used with students in the classroom.

Summer technology courses at the UML College of Education are often under-subscribed. It was anticipated that 6-8 persons would register for the Internet course. When it became apparent that more than 12 students had registered, efforts were made to limit enrollment to 12 and add a second session. In all, 27 students participated in two back-to-back sessions of the course in July and August 1993.

Students were given accounts on the ACC VAX for use as long as they are students at UML. Accounts use DCL-level VMS commands. A Gopher client became available during the Summer 1993 and the LIBS/Sonoma program also became available. The computer lab at the University of Massachusetts at Lowell (UML) College of Education has six Macintosh LC II's each running NCSA Telnet, TurboGopher and Fetch.

The first section of the course included several very experienced computer- and network-users. These individuals contributed peer teaching and challenged the class with sophisticated ideas. Participants in the first session were generally more adventuresome. For example, they jumped ahead with TurboGopher before the syllabus introduced Gopher, and they experimented with FTP resources in preparing their annotated bibliographies. The second section had less experienced users, tended to follow the syllabus exactly, and needed explicit instruction to link the skills discussed in the reading to their exploration. The second session of the course made less use of outside speakers, in favor of hands-on Internet use.

Participants had three small-group assignments: first to propose an Internet-based project that met a curriculum need; second, to produce an annotated bibliography of Internet resources that supported the project; and a final project that could be taken back to the participant's school. Final projects were expected to integrate the course reading, to address a real or likely curriculum problem, to incorporate good project methodology, to incorporate participants' expertise with instructional design and materials development, and to show evidence of using multiple Internet tools (Mail, Listservs, Gopher, LIBS/ Sonoma, Telnet, and FTP).

Participants in both sections experienced two days of panic during the first week of the course while they prepared their bibliographies. However, they quickly learned to find alternate means to locate resources when services or particular nodes were down. Collaboration in small groups created synergy that resulted in wide-ranging exploration and adaptation of goals in line with actual resources found on the network.

The final projects were mostly high quality. Topics included:

- Compilation of a K-8 resource catalog for ecology-related materials on Internet.
- Student-centered project for an urban classroom and a rural classroom to jointly explore their lifestyles and those of students in other countries.
- Feasibility of using Internet as resource base for a state-of-the-art multimedia course.

The search strategies students employed were creative and successful. The emphasis on sharing made for liberal exchange of ideas and resources among project teams. The pace of the course was a common complaint in course evaluations. Meeting every day for two weeks did not allow time to reflect on or absorb the material. Students expressed preference for 2-3 sessions per week over a regular six-week summer session.

From the instructors' point of view, the course offered a coherent experience for participants, developing basic skills, fostering creative and successful search strategies among participants, and resulting in high-quality projects that could be taken back to participants schools for implementation. At the conclusion of the course, participants requested follow-on activities. Some expressed interest in an advanced course for those using Internet in the classroom. Some wanted a mechanism for sharing successful practices.

Three-Day Project Workshop

A variation on the 3-credit course was given through Merrimack Education Center (MEC) in the Fall 1993. MEC, based in Chelmsford, MA, is an educational research center which operates several educational networks in New England. The Internet host is a VAX running VMS. Accounts use the All-in-One interface customized for individual networks. Services include electronic mail, group conferencing, archiving of popular Listservs, local educational databases, an education-focused Gopher, and general Internet access through Telnet, FTP, LIBS/Sonoma, and other tools. The training facility for the 3-Saturday Project Workshop was a roomy lab with 12 Mac LC III's and a file server networked via 56KB line to the Internet host.

The cost for the workshop was less than half the usual cost for a 3-credit course at a public institution of higher education. The Internet Project Workshop was held on three successive Saturdays in the Fall, full day sessions that aimed at producing a project that could be taken into the classroom or used in support of curriculum development activities in the participant's school district.

None of the participants had Internet accounts of their own and none had experience with Internet other than demos. Fortunately, the small class size and the enthusiasm of the participants helped them climb the steep learning curve. Participants unanimously agreed that learning to transfer software and decode/decompress it for use in their schools was their highest priority. They succeeded in learning FTP and Kermit and in applying BinHex and UnStuffIt, and each took home multiple shareware packages and Internet documents for dissemination to others in their districts.

The intense focus on shareware left little time for exploring project ideas or discussing project methodology. The experience pointed out the need for teacher instruction on obtaining shareware from the network, along with virus-protection issues, copyright issues, and software evaluation and integration concerns. As a result, a workshop devoted to "Shareware on the Internet" is in development for computer coordinators, media specialists, and other technology leaders in K-12.

The experience also suggested that for a shortened workshop to result in well-formed projects, participants would need prerequisite experience with a variety of

Internet tools and would need to be actively involved in using the network for activities like electronic mail and conferencing.

One-day Subject-specific Workshops

A series of subject-specific "Internet in the Curriculum" workshops were planned through the Merrimack Education Center (MEC) for Fall and Winter 1993-94. The curriculum workshops were developed for four areas of the curriculum: Math/Science, Language Arts, Library/Media, and Social Studies. Participants were required to have Internet experience. The one-day workshops focused on Internet resources for their subject area, projects currently operating, models and themes for new projects in the subject area, strategies for finding materials, and strategies and obstacles for involving students in Internet-related activities. The Library/Media workshop assumed that attendees would act as technology leaders in their districts, and so materials and strategies for staff development were featured, along with search strategies and reference materials.

About half of the workshop time was planned for hand-on exploration of Internet resources. Participants were expected to critique the resources they explored and share them with the class. Along with developing skills and awareness of resources and project opportunities, it was hoped that participants would develop a collaborative relationship with others in the class, follow through with development ideas, and share their successes with one another.

A pilot for the workshop was given as part of an Inservice Day in Southern New Hampshire. Foreign language teachers from four school districts gathered for a 4.5 hour session on "Internet in the Foreign Language Curriculum." Opportunities for pen pals, library searches in other languages and cultures, Gopher exploration in other countries, and other foreign language materials were demonstrated. Small groups brainstormed an Internet-related activity for their students. The activities they proposed were realistic.

One drawback to the subject-specific approach to Internet in the Curriculum is that it may preempt multidisciplinary efforts. It also requires the instructor to explore resources in depth for each strand. It is hoped that as this type of training continues, more classroom teachers with Internet expertise will take an active role in shaping the workshops.

Research-focus Training

A series of no-cost classes were offered at the UML College of Education during the Fall semester as an experiment in Internet training to support student and faculty research. Because there was no credit involved, it was unrealistic to expect participants to make a commitment for all five sessions or to do assignments between sessions. There were no prerequisites.

The two-hour sessions were offered on Saturday mornings in September and October. Contents of the session were:

1. Libraries on the Internet
2. Journals on the Internet
3. Work in Progress
4. Databases and Reference Works
5. Internet Access From Home

It was anticipated that fewer than 10 participants would come to the sessions on Saturday mornings. Nineteen students and faculty came for the first session. The number of participants dropped to 12-15 for subsequent sessions. Eight students consistently attended four or five of the sessions.

For the first session, students practiced formulating search strategies on UML's online public access catalogue and then applied the same strategies for Boston Library Consortium libraries. Motivations for searching distant or foreign libraries were discussed, and participants chose non-local libraries to explore through TurboGopher or LIBS/Sonoma. As with other sessions, the Internet resources were presented in the context of educational research activities.

The most popular tool for participants throughout the sessions was TurboGopher, and the most popular resource was the ERIC database. Many participants, including novices, found documents relevant to their research, and their success motivated them to explore additional resources. Highest hit rates were in the AskERIC resources, the ERIC databases, and various education Gophers, such as Armadillo and CoSN. Those preparing grants were drawn to OERI, NSF, and other sources of grant information.

Using TurboGopher and other relatively friendly tools was a deliberate attempt to get students using Internet without requiring them to deal with VMS or command-level Internet access commands. Since tools like TurboGopher and Fetch are available in the College of Education computer lab, participants have ready access to them while on campus.

One clear lesson from the Internet classes for researchers is that search skills and familiarity with online information resources are not necessarily well developed among graduate students. Classes needed to address Boolean searching, the nature of journal article databases, how to access the full text of ERIC documents and journal articles, and other search skills.

Discussion

Several lessons were learned from the Internet training experiences. First, human networking is a key element of successful use of the Internet by educators. Human networking is an important component of search strategies for locating or even knowing about new resources. Collaboration is important in the generation of ideas for Internet-based activities in the classroom and in staff development. Collaboration also contributes to the development of realistic projects and, we can reasonably assume, lends support during implementation, and is a factor in evaluation and dissemination of ideas following implementation.

Strategies for involving educators in use of Internet must get users past the basic skills and past the unfriendliness of Internet. The primitive tools available to most users at this stage— command-level Telnet and FTP— are non-intuitive and cryptic in the error messages they generate. While Gopher and LIBS/Sonoma are a step up in their menu-based interfaces, they still rely on non-robust services that can hang or mysteriously quit in the middle of operations.

One strategy for keeping users going is to use point-and-click tools and demos that expose them to the wealth of resources on Internet before requiring them to learn the details of basic tools. Exploration with TurboGopher early in training can give users successful experience with the resources on the Internet that are relevant to their interests. In this exploration, Veronica, WAIS, and Archie are helpful tools, as are the collections of library resources and popular FTP sites. LIBS/Sonoma is another good introduction to library resources and databases. Fetch is a helpful introduction to the power of FTP, since it automatically handles decoding and decompression. Once users have had success with finding Internet resources and getting them in-hand for re-use, they are more receptive to learning the details and steps involved in dialing into an Internet host and using command-level Internet access tools. A surprising number of users, once they have seen what is available, are willing to search for shareware from home, initiate a file transfer, use Kermit to pull the resource onto their Mac or PC, even if it will take hours, then decode and decompress it.

Those who want to use Internet in the classroom and those who will do staff development in Internet in their schools express concern about the interfaces their students and fellow teachers will have available to them. Their struggle with learning primitive tools has made them cautious about trying to teach basic skills without point-and-click tools and fast connections. For many, the solution, until more sophisticated tools are widely available, is to limit the skills they teach to one or two tools, such as electronic mail and Gopher or LIBS/Sonoma.

One aspect of Internet can be viewed as a negative or a positive, depending on how it is presented. The dynamic nature of Internet and the proliferation of resources can be overwhelming to new users. The instructor can turn this around to engender excitement in the ever-increasing resources. New services become available on any given week, and the instructor can feature new resources as a warm-up activity. Other opportunities for welcoming the changes on the Internet include having researchers look for dissertations in their area of interest and discussing what it will take for more dissertations to be available online. That discussion can take into account the ongoing conversations among researchers and the growth of electronic journals and gopher sites that make research findings available in a timely way.

Problems in classroom access abound in eastern Massachusetts, where few schools are networked and it is a major battle to get a telephone line into a classroom. Teachers who are enthusiastic about using Internet are not willing to wait for the development of the Information SuperHighway or even a statewide network that reaches into their classrooms, although they see these as ultimate goals. They want access for their students and fellow teachers as soon as possible, both for the many resources unavailable elsewhere and for the worldwide communications opportunities.

Further training is being planned at this time, taking into account the lessons learned and the demand that has arisen as a result of the training discussed here. A workshop on "Shareware on the Internet" is in development, which addresses locating and transferring shareware, along with virus-protection, copyright, software evaluation and integration, and other key issues related to educational software. Another 3-credit summer course for graduate teachers will include the shareware segment and will take advantage of the growing body of infusion ideas and successful Internet practices. The three-Saturday workshop will be offered again with more stringent prerequisites. Greater emphasis will be placed on collaboration following the workshops and courses, through use of electronic mail and discussion groups. The author will continue this research by surveying participants in the Summer and Fall training in regard to their continuing use of the Internet, their experiences using Internet in the classroom or with their colleagues, and their follow-on training needs.

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Diversifying Instructional Delivery: Design and Implementation of a Distance Learning Program Using Telecommunications

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The purpose of this paper is to report on the implementation of the Learn From A Distance (LFAD) Program, sponsored by the College of Education, University of South Florida. LFAD is one of the ways in which the college is responding to the changing needs of the program and the students it serves. Our college, like many other colleges throughout the nation, is under pressure to increase the effectiveness and expand the delivery of curriculum while increasing FTE. It is called upon to improve or even reinvent curriculum through the use of technology, to build new programs for new constituents who have evolved out of the advancement of technology, and to find flexible delivery systems for expanding populations with unique needs — single parents, full time employees, and students who live too far to commute. The long term goal of LFAD is to use technology to provide unique curriculum experiences for populations having diverse needs while exploring alternative delivery methods.

Development of the Learn From A Distance Program

The Learn From A Distance Program is in its third year of operation. It was made possible in 1991 when the Florida Information Resource Network (FIRN) offered electronic mail (FIRNMAIL) at no cost to public educators in the state. Until then, there was no economically feasible way for the college to support course offerings through telecommunications. FIRN is funded by the Florida Department of Education and was founded in 1982, primarily to meet the administrative needs of the school districts.

The pilot course for the LFAD program was offered in the spring of 1991. This course, Microcomputers in Education, was a regularly scheduled course in the Instructional Technology Master's Degree program. It was chosen as the experimental course because it met several criteria: 1) The course appeared to be easily adapted to a LFAD format (e.g., a course that could be effectively delivered via telecommunication). 2) It was an introductory course that would have broad appeal to educators in a number of content areas. 3) It would apply to teacher recertification in all areas specified by the Florida Teacher Certification Program. 4) Most importantly, there were many educators in the state who had learned, by their own initiative, a considerable amount about technology and had, to varying degrees, infused technology into their own professional environments. Many did not have local support systems and often their efforts went unrecognized and unrewarded by supervisors and peers who had little knowledge of the computer technology and applications available for education.

Through evaluation activities, the LFAD staff identified a set of standard procedures for implementing courses and expanded the course offerings. Currently, LFAD offers six courses from the Instructional Technology Master's Program:

Basic Tools. This course is an introduction to the use of high level programming languages to collect and manipulate research data in education.

Enhancing Instruction. This course is a contract course in which the learner completes a substantial project integrating technology into their professional environment.

Programming Languages for Education. This course is used to offer a range of programming languages that have professional application for the learner. Offerings include Hyperscripting, Linkway and Pascal.

Microcomputers in Education. This course is a survey course designed to introduce practicing teachers to microcomputer technology and its function in the classroom to augment the teaching and learning processes. Topics include word processing, spreadsheets, database, videodisc, and software evaluation.

Microcomputers for School Management. This course provides information and skills necessary for administrators and teachers to effectively use the microcomputer and application software in more efficient ways to manage information.

Telecommunications in Education. This course emphasizes the concepts, strategies, and materials need for using telecommunications in the management and enhancement of instruction. Topics include FIRN (Florida Information Resource Network), Internet, file transfers, electronic databases, uses of telecommunications in the classroom, and ethical and legal issues in telecommunications.

A General Scheme For Operations

A great deal of time was committed to the development of a general scheme for operations. We felt that this investment of time would be beneficial in expanding the LFAD Program. With the following major components identified, defined, and standardized, the LFAD staff hopes to work with all departments in the College of Education to expand the course offerings into other areas of the curriculum. See figure 1.

Recruitment

Several techniques are used to recruit students. Each semester, a general brochure is updated to include current LFAD offerings. This brochure is distributed by Instructional Technology and LFAD staff at conferences and by several FIRN personnel at workshops. It is also sent as part of an information packet to media specialists, school computer technologists, staff development personnel for school systems in the state, and individuals on the LFAD mailing list. The information packet contains the brochure, course descriptions, answers to frequently asked questions, and an application form. Individuals requesting more information about the LFAD program are sent the information packet and automatically added to the LFAD mailing list. In addition to mailings, a notice and description of the program and course offerings are posted on a FIRN bulletin board and in several Internet news groups each semester.

Registration

Registration involves two components: 1) establishing criteria for acceptance into a LFAD course and 2)

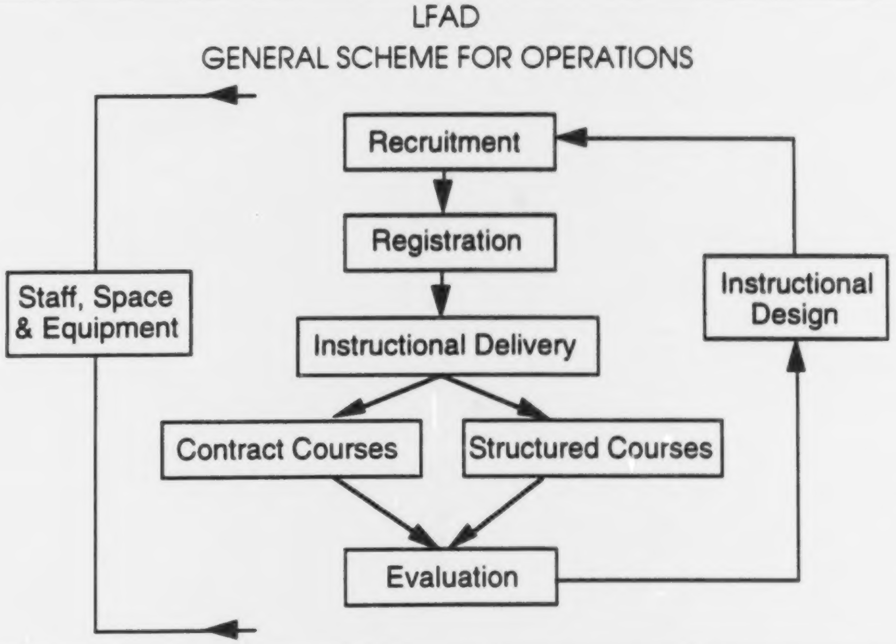

Figure 1. LFAD General Scheme for operations.

establishing a registration process.

Criteria. Criteria for acceptance into a LFAD course have been identified. Individuals must have basic computer skills, be self-motivated, and have continuous access to a computer with a modem. To apply for enrollment in a course, individuals complete the form that is included in the information packet. This includes a signed statement indicating that the learner has appropriate equipment and basic knowledge of computer operation. They also write a brief autobiography that describes their personal and professional background and goals. If accepted into a LFAD course, they are sent a registration packet.

Registration. Establishing a registration process is more complicated then it may appear on the surface. We studied the policies at our institution and worked closely with the appropriate personnel to prevent possible complications. Each institution has unique policies that affect the registration process; often, there may be several methods of registration to explore before finding the system that works best.

Delivery of Instruction

An orientation meeting is scheduled on campus each semester for LFAD participants. This conference-type meeting is very effective in terms of acquainting individual students and the LFAD staff with one another, providing course orientation, answering questions, generating enthusiasm for the program, and reducing anxiety for students who may be apprehensive about distance learning. General orientation, course descriptions and opportunities for social interaction are provided for the entire group, after which special small sessions are held to provide orientation for specific courses.

A final on-campus meeting is scheduled so that participants can demonstrate projects, turn in materials they have completed, take final exams, participate in sharing experiences, and complete course evaluation activities.

All other learning experiences are implemented at the learner's site. Learning experiences involve a range of activities consisting of structured assignments, independent projects, or online sessions with other individuals or groups. Based on data collected during course delivery, special on-campus sessions are planned for students who are experiencing difficulty or have other special needs.

Instructional Design Of Courses

The instructional design of each course is implemented in one of two ways: a contract course or a structured course. A contract course is one that is initiated by the learner. The learner designs a substantial project or product that meets criteria that have been established by the Instructional Technology Program. This project is accepted or rejected on the basis of feasibility, importance, and compliance with the established criteria. If accepted, the student enters into a contract with the LFAD program to complete the course within the semester with the understanding that no grade of incomplete can be given. Over the last three years, several exemplary projects have been completed. For example:

1) One learner worked with architects to plan the technology for a special education school. She was involved with the planning and purchasing of the equipment, software and furniture and made decisions on placement and networking options. Her final paper shared her experiences, successes, and frustrations for others to use as a guideline.
2) A junior college instructor developed a user-friendly DOS manual and tutorial to be used for instruction. Two years later, they are still using the manual at the junior college, and with the learner's permission, several portions of it have been adapted for use in our on-campus undergraduate Introduction to Computers in Education course.
3) A fifth grade teacher organized several classrooms throughout the state to participate in a unit on Florida Indians. The classes shared daily experiences via telecommunications with each other and with anthropologists working in the field.

A structured course is one in which the LFAD staff have developed a specific set of course guidelines, expectations, and materials. The instructional design for structured courses consists of three important components: 1) Course Material Packet; 2) Course Project; and 3) Personal Resource Packet. The Course Material Packet contains instructional experiences that the learner completes in order to fulfill the requirements of the course. The Course Project is a project designed and created by individual learners to apply what has been covered in the Course Packet to their professional environment. Suggestions and guidelines are provided that help learners complete individual projects. The Personal Resource Packet is a set of materials that the learner constructs to document the fulfillment of course requirements. It also serves as a resource for use in the learners' professional work or study.

Course Material Packet

The Course Material Packet consists of activities, each of which contains the following elements:

1) Learning objectives. These are statements that indicate skills or concepts to be acquired or products to be created.
2) Resources needed. This is a list of materials, readings, software programs, disk text files, or equipment needed for completing the activity.
3) Assignments for completing learning objectives. This is a set of directions for completing an activity. Certain assignments require immediate feedback. These assignments are sent to the LFAD office via e-mail for assessment and feedback. Other assignments are completed as exercises or as a resource for the learner. For example, a learner may be required to use a spell checker, a thesaurus, or an online encyclopedia to complete a document. The learner may or may not be required to send in the assignment, depending on its content. However, all assignments are documented in the Personal Resource Packet.

4) Timelines. This is a set of suggested time periods for completing each activity.
5) Checklists. This is a checklist that tracks progress in an activity. They serve two purposes: a) They confirm for the learners that they have completed all the assignments for an activity and b) As the checklists are completed, the learners send them to the LFAD office for statistical interpretation. They provide the LFAD staff with information regarding group progress as well as individual progress. This information is used to pinpoint specific problems, improve instructional materials, and to improve general course operation. For example, figure 2 shows which activities had been completed by students as of November 2nd, in the Telecommunications in Education class, Fall 1993.
6) Self tests. This is a set of materials that allow learners to evaluate their acquisition of the learning objectives.
7) Course Survey. This is an instrument that allows the learner to express their opinion concerning the effectiveness of each activity. It contains a rating scale and a few free-response items for each activity. The survey is completed as learners finish each lesson and is returned anonymously to the LFAD office at the end of the course.

Mastery of Learning Objectives

Grades are awarded based on the quality of and timely completion of course assignments, projects, and final presentations. Learners have many opportunities to redo assignments, responding to feedback received from other LFAD students and the LFAD staff. Course work must be completed, however, within the semester of enrollment. There is no provision for students who cannot complete course work within the time allotted except in extraordinary circumstances.

Evaluation

Evaluations of the effectiveness of LFAD courses are done at the end of each semester. The most important tool in our evaluation process is the Course Survey completed by the learners. Many LFAD students have suggested excellent changes or new additions to the course materials. The LFAD staff provides observations of the difficulties encountered by learners and compiles statistical information. The staff meets with the professor of record to discuss the evaluations and revise the course materials.

Staffing, Space, and Equipment

The success of the LFAD program at the College of Education, University of South Florida is directly related to special considerations for staffing. A differentiated staffing technique was used to develop staff positions and descriptions. This consisted of the master teacher concept in which a variety of assistant teaching levels were identified to support instruction at several different layers.

Staffing

The staff positions for the program include:

Professor of Record. This person is responsible for specifying the content of the course, overseeing the development of course design, and resolving major conflicts that occur during the implementation of a course. Once a course has been developed, the service of this faculty member is greatly reduced.

Program/Course Administrator. As Course Administrator, this person is responsible for the day-to-day operation of a course or several courses. This person works closely with the professor of record and writes and revises course material, answers routine correspondence, evaluates the completion of routine assignments, and trouble shoots. As Program Administrator, this person is also responsible for the planning and operation of the program as a whole, including developing and refining recruiting and registering procedures, preparing mailings, offering workshops, and handling university paperwork, etc. As the LFAD program grows, we anticipate having several Course Administrators working under the supervision of the Program Administrator.

Instructional Assistant/Clerical Assistant. This person assists the Program Administrator in the day-to-day operations of the courses, handing information requests, filing, word processing, maintaining databases, and organizing statistical information. Generally, this is a part-time position filled by graduate assistants or students.

Several important outcomes result from using the differentiated staffing techniques and the master teacher concept. An infrastructure is created that encourages cooperative team building and produces an environment in which staff at early stages of development can grow while performing important functions. The professor resource is preserved for the most essential instructional functions or tasks. Resources are maximized, learning opportunities are consistent, and the program is not dependent on the abilities or availability of one professor.

Space and Equipment

To develop the infrastructure necessary to make the program successful, staff should be in a central location and should be fully committed to the program. Also, it is extremely important that staff have their own equipment; sharing people, resources, or equipment with other areas can interfere with the operation of the program.

Summary of Outcomes, Limitations, and Plans for the Future

Learn From A Distance is a low-cost system that does not depend on real-time video of elaborate multimedia presentations. Our program fills an important niche for a population that was not served prior to the establishment of LFAD. While attracting learners who are not part of a degree seeking program at the University of South Florida, LFAD has motivated many of them to apply for enrollment in the Instruction Technology doctoral and masters programs. Although our program is small, enrollment is increasing.

We hope to expand the LFAD course offerings to include graduate courses from other programs. As of this paper, LFAD courses are being considered by the English Education, Adult and Vocational Education, Business Education, and Mathematics Education Departments. We would also like to attract learners from outside the state of Florida who would take the courses via the Internet. While there are difficulties to offering courses over the Internet, such as out-of-state tuition requirements and the number of potential learners who have access to the Internet, we believe the opportunities are exciting and worth exploring.

Another limitation to LFAD's ability to attract students is that we cannot accommodate naive learners who have no computer skills. We would like to encourage all educators to explore technology and how they can integrate it into their professional environment. Unfortunately, it is imperative that LFAD students possess a degree of computer skill.

We also recognize that there are many courses that we cannot hope to deliver because of their nature. For example, a Special Education course requiring experience in the field would be difficult to deliver via telecommunications. As would a course, such as Interactive Media, that requires technology to which we cannot expect all learners to have access.

Despite the limitations, LFAD is receiving more requests for enrollment than we can currently accept. The program has made positive educational opportunities available for nontraditional students and has helped to create a substantial communications network of educators with mutual interests. For the College of Education, University of South Florida, Learn From A Distance represents a start in a new direction.

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The Influence of Conference Moderator Strategies on the Participation of Teachers in Collaborative Telecomputing Projects

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In Virginia, a statewide public school computing network, Virginia's Public Education Network (Virginia's PEN) is available to any public school educator who wants an account and has access to a computer, a modem, and a telephone line. Virginia's PEN allows users easy access to the Internet, the academic computing network which links universities and other educational agencies throughout the world. Virginia's PEN connects the public schools to the academic world of higher education and facilitates school/university partnerships and provides access to government agencies and commercial businesses (Bull, Sigmon, & Cothern, 1992).

The instructional use of networks by educators and students has been the subject of a limited body of research. Although there have been many studies dealing with using technology for educational purposes, most have focused on assessing the impact of computer-based instruction, such as drill and practice (Roblyer, 1989). Recent research has expanded this scope to include the use of telecomputing networking systems and how they relate to education. The purpose of the study was to develop and evaluate a series of procedures which could be used by a conference moderator to encourage educators and their students to participate in collaborative projects over Virginia's PEN.

Online Instructional Pavilions

The Electronic Academical Village is the name given to a series of instructional resources on Virginia's PEN. Instructional content areas called "pavilions" have been created for subjects such as history, mathematics and science, aerospace, and multicultural education. Within the pavilions, Virginia's PEN users can access a variety of resources, including discussion groups, archived lesson plans, interactive projects, and an electronic suggestion box.

The Electronic Academical Village was established to allow those interested in education from across Virginia to collaborate on a series of interactive instructional activities which take place over Virginia's PEN. The Electronic Academical Village began with two prototype pavilions, the Math and Science Pavilion and the History Pavilion. The intent of each pavilion was to include online discussion groups, where teachers could share information and ideas about classroom activities, ask questions of educators from other locations, and develop collaborative projects with classes in other schools and specialists from educational agencies.

The Role of the Pavilion Curator

Just as a museum or art gallery has people who oversee the exhibits and keep them timely and topical, the Electronic Academical Village concept promotes the use of curators to organize and maintain pavilions. Curators would volunteer to answer questions, post items of interest, and generally facilitate use of the network for instructional exchange. Curators might help teachers locate content specific resources from the many that are available on the Internet, suggest classroom activities, and encourage discussion and network interaction among Virginia teachers and students.

Curators had been identified for the two prototype pavilions but were untrained at the time of this research study and activities within the pavilions were sporadic and lacked organization.

Development of an Instructional Telecomputing Strategy

As part of the study, a number of procedures were developed by the author who served as an acting curator for the Math and Science Pavilion. These procedures were designed to foster increased participation and a greater degree of appropriate postings to discussions within the Electronic Academical Village pavilions. These procedures included specific guidelines targeting the Math and Science Pavilion as an area on the network where students, teachers, and other educators could participate in meaningful discussions and successful collaborative networked projects related to math and science. Specific mechanisms were identified and used to encourage participation in online discussion groups and promote participation in online projects, where data were shared across the network. It was envisioned that these procedures could later be adopted for use in training curators of existing and future instructional pavilions as well as moderators of instructional activities on other similar network systems. For the purpose of this study, the set of procedures was known as the Instructional Telecomputing Strategy and included the following items:

Network-Related Procedures

1. Creating menus, submenus, and links to instructional resources
2. Removing outdated and inappropriate materials in a timely manner
3. Re-posting inappropriately placed materials to a more appropriate location and contacting the original poster to explain why the material was moved
4. Archiving materials of long term interest
5. Coordinating the identification and placement of resources to be added

Interpersonal Procedures

6. Encouraging Virginia's PEN users, via electronic mail, written correspondence, and telephone calls, to log onto the Math and Science Pavilion, join the discussions, and participate in online projects
7. Answering questions and comments posted to the Suggestion Box
8. Working with the Virginia's PEN technical support team to solve technical problems and implement desired network modifications
9. Meeting with educators who could serve as facilitators to promote the concept and use of the Math and Science Pavilion
10. Working with agencies and others who needed Virginia's PEN accounts and training to participate in network projects

Additionally, the Instructional Telecomputing Strategy included specific items related to establishing and maintaining the online conderence, including:

11. Preparing and posting an enticing initial agenda related to the instructional theme of the conference
12. Establishing expectations of the conference and suggesting guidelines for online posting
13. Explaining unclear remarks in the discussion and requesting clarification when necessary
14. Periodically summarizing the state of the discussion
15. Unifying threads in the discussion to meet the instructional goals of the conference

This Instructional Telecomputing Strategy formed a framework for training curators to create and maintain the pavilions of the Electronic Academical Village. Curators had previously been selected for the prototype pavilions, and new pavilions have been added or are planned with additional curators. Previously, curators had received minimal direction and support in developing their pavilions. This study focused on developing and evaluating an instructional strategy for potential adoption by the developers and administrators of Virginia's PEN, which could be used to train existing and future pavilion curators.

Research Questions

Based on previous research of instructional uses of computer networks, the set of strategies was developed for use by pavilion curators to guide them in their support of network projects. After development, the strategies were implemented in the Math and Science Pavilion for a period of six weeks and data were collected relating to the number and appropriateness of postings in two areas of the pavilions. The following research questions were developed to evaluate the Instructional Telecomputing Strategy:

Does implementation of the devised Instructional Telecomputing Strategy, affect:

1. the amount of participation by educators in online collaborative math and science projects, as measured by the number of postings to Math and Science online discussion groups
2. the appropriateness of postings by educators in online collaborative math and science discussions and projects

Data Collection

The effectiveness of the Instructional Telecomputing Strategy within the Math and Science Pavilion was evaluated based on the amount of participation and the appropriateness of postings by Virginia's PEN users. Frequency counts were used to gather data on the number of postings that were made to selected discussion groups in the pavilions. The appropriateness of postings was rated by three trained observers using categories of appropriateness developed for this study based on recommendations by Feenberg (1986). The following appropriateness scale was used to classify postings:

- a posting is appropriate to the instructional theme

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of the pavilion

- a posting is appropriate to the instructional theme, but posted in the wrong place
- a posting is not appropriate to the instructional theme of the pavilion

Data Analysis

The number of discussion group postings and the appropriateness of these postings were both analyzed to determine the effect of the Instructional Telecomputing Strategy.

Number of Postings

Chi Square tests were used to analyze the number of postings made during this study. Chi Square tests were used to test the hypothesis that the treatment implemented during the study affected the number of postings in the Math and Science Pavilion. The data which were analyzed included postings from both the baseline period and the treatment period. For both of these six-week periods, Math and Science Pavilion postings and History Pavilion postings were examined and compared.

Appropriateness Ratings

As part of the study, inappropriate discussion group postings were examined. The percentage of items "posted in the wrong place" in the Math and Science Pavilion and in the History Pavilion were examined and compared. These data were analyzed using a z-test of significance for computing the difference between two independent proportions.

Results

The following results were collected from a combination of frequency counts and computer-tracked data acquired during and following the twelve weeks of the study. Statistical analysis of the data was performed and the results are also presented.

Implementation of the Instructional Telecomputing Procedures

During the six-week treatment period, the acting curator implemented the procedures from the Instructional Telecomputing Strategy designed to encourage Virginia's PEN users to participate in interactive discussions and online collaborative projects. There were 219 occurrences of procedures from the Instructional Telecomputing Strategy implemented during the six weeks of the treatment period with an average of thirty-six occurrences implemented per week. The number of times each procedure was employed is displayed in Table 1.

During the treatment period, four additional procedures were created which were not included in the original fifteen items developed. Procedure 16, "Develop a Core Group" was created as a new procedure in response to the formation of a group of interested educators gradually emerging during the treatment period. This core group's continued participation in the pavilion necessitated creation of a procedure that extended beyond the scope of Procedure 6, encouraging users to logon and join the discussions.

Number of Postings

The number of postings in the Math and Science Pavilion and the History Pavilion discussion groups were compared during the baseline and treatment periods. Figure 1 compares the number of postings in the two pavilions during the twelve weeks of the study. The following chi square results explain the comparison of the postings in both pavilions:

1. The average number of postings in the two pavilions was approximately the same, with 7 vs. 9 postings per week during the baseline period (chi square = .25, df = 1, $p > .05$), but were significantly different during the treatment period (chi square = 80.2, df = 1, $p \leq .05$).

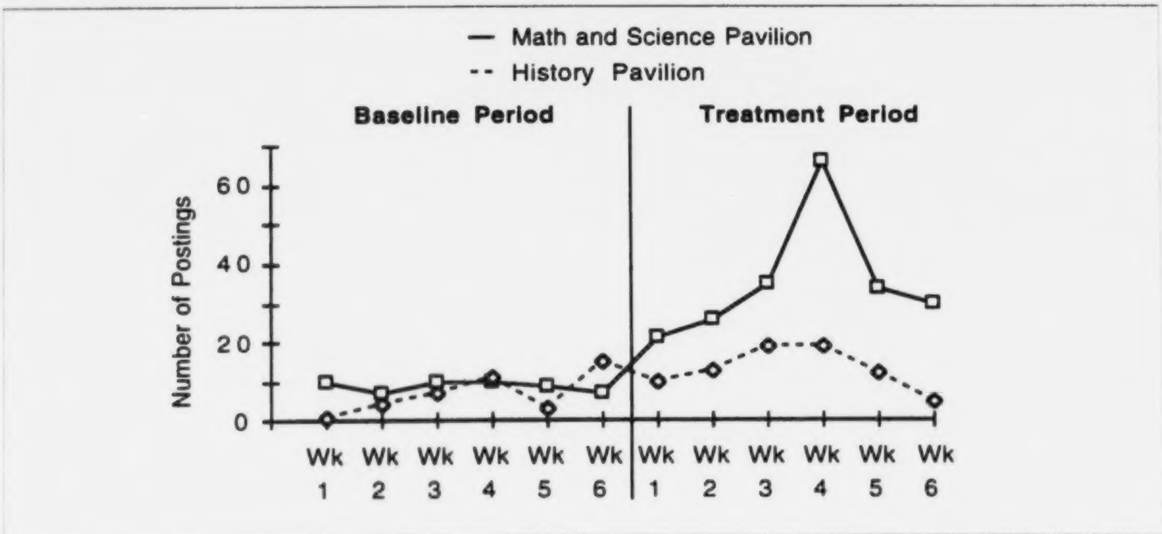

Figure 1. The Number of Postings in Both Pavilions during the Baseline and Treatment Periods.

Table 1
Instructional Telecomputing Procedures

	Week During Treatment Period						
Procedure	**One**	**Two**	**Three**	**Four**	**Five**	**Six**	**Total**
1. Menu Maintenance	2	1	3	3	3	1	**13**
2. Remove Outdated Material		1	2	3	1	1	**8**
3. Re-post Materials		4		1	4		**9**
4. Archive Items						1	**1**
5. Coordinate New Resources		1	3	1		1	**6**
6. Encourage Participation	10	18	21	10	9	10	**78**
7. Answer Questions	3		2	2	4	2	**13**
8. Technical Support	1		1	2	2	5	**11**
9. Interpersonal Contact			7	6	2	3	**18**
10. Work with Agencies	2	4	2	1		1	**10**
11. Prepare Initial Agenda							**0**
12. Suggest Guidelines	2	1		2			**5**
13. Explain Unclear Remarks			1	1			**2**
14. Summarize the Discussion					1		**1**
15. Unify Threads							**0**
16. Develop a Core Group		1	3	10	9	8	**31**
17. Create Training Materials				1	1		**2**
18. Post Items in the Pavilion				3	3	2	**8**
19 Post Items in Other Locations		1	2				**3**
Total per Week	***20***	***32***	***47***	***46***	***39***	***35***	***219***

2. The average number of postings in the Math and Science Pavilion increased significantly (chi square = 75.1, df = 1, $p \leq .05$) during the treatment period.
3. The average number of postings in the History Pavilion increased during the treatment period; the increase was significant at the .05 level (chi square = 5.1, df = 1, $p \leq .05$).

The number of postings in the History Pavilion also increased during the treatment period. The increased number of postings in the comparison group, where no treatment was implemented was associated with the popularity of a single project, Jefferson Online, which accounted for the majority of the postings in the History Pavilion during the baseline and treatment periods. The number of postings in each pavilion is shown in Table 2.

Appropriateness Ratings

The three raters evaluated all of the postings which were made in the Math and Science Pavilion's Roundtable and the Projects discussion groups during the six-week baseline period and the six-week treatment period. The raters also evaluated all of the postings in the History Pavilion's Roundtable, Projects, and History Online discussion groups made during the same periods. For this study, it was required that two of the three raters agree on a classification. For example, if a posting was rated as "posted in the wrong place" by two of the three raters it was counted as inappropriate. However, if only one of the three raters thought the posting was posted in the wrong place, it was counted as appropriate.

A number of postings judged to be inappropriate by the pavilion curator had been observed in the pavilions prior to this study. For this reason, the factor of appropriateness was selected to be examined. However, no postings which were inappropriate to the instructional theme of the pavilion, as judged by a consensus of two out three raters, were identified during the study. A small number of postings were judged to be posted in the wrong place, as shown in Table 3.

The percentage of items "posted in the wrong place" in the Math and Science Pavilion fell from twenty-three percent during the baseline period to fourteen percent during the treatment period. The percentage of inappropriateness in the History Pavilion discussion groups rose from fifteen percent during the baseline period to eighteen percent for the treatment period.

These postings were analyzed using a z-test of significance for computing the difference between two independent proportions. Results of this test indicate that even though the percentage of inappropriate postings rose in the History Pavilion discussion groups and fell in the Math and Science Pavilion discussion groups, the difference is not statistically significant.

Table 2
Number of Postings per Week

Number of Postings per Week

		Baseline	*Treatment*
Math & Science Pavilion	Week 1	10	21
	Week 2	7	26
	Week 3	10	35
	Week 4	10	66
	Week 5	9	34
	Week 6	7	30
Average		*8.8*	*35.3*
History Pavilion	Week 1	1	10
	Week 2	4	13
	Week 3	7	19
	Week 4	11	19
	Week 5	3	12
	Week 6	15	5
Average		*6.8*	*13.0*

Users Who Posted Most Frequently

A relatively small number of Virginia's PEN users were active participants in the two pavilions. During the treatment period, the number of users who posted items more than doubled in each pavilion. In the Math and Science Pavilion, the number of users who posted increased from twenty-nine during the baseline period to fifty-seven during the treatment period. For the History Pavilion, the number of users who posted increased from ten users during the baseline period to twenty-eight users during the treatment period. As shown in Table 4, thirty-nine different network users accounted for all of the postings in the two pavilions, during the baseline period, and eighty-five users accounted for all of the treatment period postings observed during this study.

The findings from this study indicate that a relatively small group of high-frequency users accounted for a large percentage of the postings. Rogers' (1986) findings about information systems, which suggest that ten percent of users account for fifty percent of all use, proved to be true in the Math and Science Pavilion during the treatment period. During that six weeks, ten percent of the users (six individuals) posted 101 items or forty-eight percent of the total number of postings made in the pavilion during the treatment period.

Contact by the Pavilion Curator

The users who posted most frequently to the Math and Science Pavilion discussion groups were repeatedly contacted by the curator during the treatment period. These users became a core group of interested pavilion participants who received intensive and ongoing support and encouragement from the curator during the treatment period. Electronic mail was the most common method of contact, with telephone calls and in-person meetings also occurring. In-person meetings included informal conversations, classroom training sessions, and formal presentations.

Recommendations for Pavilion Curators and Other Conference Moderators

Based on the implementation of the Instructional Telecomputing Strategy, the findings from this study, and conversations with educators involved with the Electronic Academical Village pavilions, the following recommendations are made for future pavilion curators to use to increase participation in online instructional projects. These strategies should also be useful to other network conference moderators who may be able to adapt these strategies for use with other network systems.

1. Develop a core group of motivated participants.
2. Select a few educators who can help with the develop-

Table 3
Appropriateness Ratings for Math and Science Pavilion and History Pavilion

Math and Science Pavilion

	Baseline	Treatment
Total Number of Postings	53	212
No. Rated as "posted in wrong place"	12	29
No. Rated as "not appropriate to theme"	0	0
Percentage of Inappropriate Postings	23%	14%

History Pavilion

	Baseline	Treatment
Total Number of Postings	41	78
No. Rated as "posted in wrong place"	6	14
No. Rated as "not appropriate to theme"	0	0
Percentage of Inappropriate Postings	15%	18%

Table 4
Number of Postings and Number of Users

	Baseline Period		Treatment Period	
	No. of Users	Accounted for:	No. of Users	Accounted for:
Math &Science Pavilion	29	53 postings	57	212 postings
History Pavilion	10	41 postings	28	78 postings
Total	*39 users*	*94 postings*	*85 users*	*290 postings*

ment of the pavilion. Invite those who seem interested and motivated to join a curator's council or board of directors for the pavilion.

3. Be an active curator through e-mail, newsgroup postings, listserv announcements, and telephone calls.
4. Plan online projects far enough in advance to allow teachers to schedule class time to participate.
5. Distribute written materials to educators about the existence of available network resources and how they can be used in the classroom.
6. If a curator is not a teacher, he or she should select a school and visit it on a regular basis to see how telecomputing is used in the classroom.
7. Try to stay informed of the many changes that are occurring on the network.
8. Allow enough time to maintain existing pavilion resources and develop new ones.

It is apparent from this study that one beneficial way of increasing both the amount and the quality of online instructional activity is by implementing an organized set of instructional strategies. Online success also is dependent on the presence of an interested curator who can give encouragement and assistance to motivated users of the network.

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The Problem Solving Corner: An Electronic Community of Math Learners

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The Problem Solving Corner is a project on Virginia's Public Education Network (Virginia's PEN) which joins K-12 students, their teachers, preservice teachers, and graduate students in mathematics education into an electronic community of learners focusing on problem solving.

The Need

The National Council of Teachers of Mathematics (NCTM) has articulated five general goals for all students in its *Curriculum and Evaluation Standards for School Mathematics*. All students should : (1) learn to value mathematics, (2) become confident in their ability to do mathematics, (3) become mathematical problem solvers, (4) learn to communicate mathematically, and (5) learn to reason mathematically (NCTM, 1989). This document agrees with the *Agenda for Action* that "Problem solving must be the focus of school mathematics" (NCTM, 1989, 6). It describes the classroom as a place where students work on problems that may require hours or days to solve, where the work is done independently on simple exercises and in small groups or even the entire class working cooperatively on more complex problems. The students are talking and writing mathematics, making conjectures, and building arguments.

The *Curriculum and Evaluations Standards* not only sets curriculum goals, but also implies "a significant departure from the traditional practice of mathematics teaching" (Brown & Borko, 1992, 210). This new methodology includes providing time and opportunity for students to "explore mathematics and grapple with ideas and problems" (Brown & Borko, 1992, 210). Unfortunately, many of the current textbooks do not yet provide the type of problems needed for such activities. The teachers are just beginning to receive the training necessary to implement such changes.

Brown and Borko (1992) note that novice teachers are often hesitant to implement the NCTM *Curriculum and Evaluation Standards* and are reluctant to relinquish the role of "authority" in the classroom as suggested in the NCTM *Standards* and the NCTM *Professional Standards for Teaching Mathematics.* Today's teacher preparation programs should address the need to change the preservice teachers' beliefs about what mathematics is and how it should be taught. The programs should provide content knowledge as well as pedagogical knowledge. In the case of problem solving, preservice teachers should learn how to solve problems themselves as well as how to facilitate problem solving and communication in mathematics.

One Role for Technology

Technology can provide one means of accomplishing these goals. A statewide telecomputing system, Virginia's Public Education Network (Virginia's PEN), has been established which provides educators in all 2,000 of Virginia's public schools with access to Internet. Not only does it assure all K-12 teachers of access to the Internet without charge, but it also provides access to individual students (6-12) and classes (K-5), and to the university community, including preservice teachers. This paper describes one way in which the system is being used to facilitate preservice training for elementary teachers in mathematics while actively engaging students around the state of Virginia in problem solving.

On Virginia's PEN, the user interface has been designed for easy use and accessibility of resources. One of the sections has been designated as the Electronic Academical Village, a modern day version of Thomas Jefferson's Academical Village, which is a collection of instructional resource nodes (called Pavilions) in various academic areas such as history, multicultural, elementary language arts, space, and physics. Each pavilion is monitored by two "curators" who serve as resources, organizers, and contacts. One of these pavilions is the Math and Science Pavilion. It contains various resources such as interactive responses by mathematics and science education experts to questions posted by students, teachers, and preservice teachers; international and local discussion groups on various topics; notes from various museums and public television pertinent to math and science; lesson plans developed by both funded projects and individual teachers; and interactive group projects.

The Problem Solving Corner for K-12 Students

One of the sections in the Math and Science Pavilion is the Problem Solving Corner. Each Monday three problems are posted by the "Problem Poser," one for K-4, one for 5-8, and one for grades 9 and above. Students from around Virginia submit their solutions by the following Monday. Participation is open to any student either on an individual or team basis. Problems are chosen as Problem Solving Corner problems based on the following criteria:

1. They capture student interest and imagination.
2. The solution is not immediately obvious.
3. The problem can be solved using more than one strategy.
4. The problem is within the computational skill level of the students.
5. The solution time is reasonable.
6. There may be more than one solution.
7. The solution is defined well enough so that students know when a solution has been reached.

Solutions may be turned in anytime before the last day of the problem cycle and are written in a specific format. This format is:

1. State the problem and any assumptions which are made.
2. Explain the strategy, or strategies. Suggested strategies are:
   a. Work a simpler case and apply.
   b. Look for a pattern to apply.
   c. Make a wild guess and check your answer.
   d. Make a table, chart, or diagram; use a model.
   e. Label known parts and unknown parts with variables.
   f. Write an equation relating the knowns and unknowns.
   g. Work backwards.
   h. Work for a subgoal.
   i. Find a related problem or strategy you can apply.
   j. Act it out.
3. Give the final solution.
4. List your name, grade level, school, city, and teacher.
5. Indicate whether you are solving as an individual or as a team.

Recognition is awarded weekly in the following categories: Outstanding Creativity, Outstanding Solution, Outstanding Effort, Outstanding Team Work, Individual Work, and Honorable Mention in each of the three grade levels. Sample solutions are posted 48 hours after the student solutions are due.

A Sample Solution

For example, in answering the problem:

> You have invited your nine friends to your birthday party. Your mother has planned an interesting way to serve the refreshments. She instructs you and your friends to line up in a line with you first. This is a shaking hands activity. You shake the hand of each friend down the line and then receive your plate of ice cream and cake. Each friend does the same, shaking the hands of the rest of the people in the line, before receiving their plate of ice cream and cake. Assuming that no person shakes any person's hand more than once, how many TOTAL handshakes are there by the time the last person gets refreshments?

the Hamilton Sneakers submitted the following answer:

> Hello! This is our first experience on here and we are thrilled! We are.....Hamilton's Sneakers.....working as a class team (David C., Ben P., Alice D., Katie C., Robin A., Stephanie C., David S., Ronnie M., Jasmine M., Andy J., Charles Z., Alex F., James B., Markel H., Sebastian A., Weston B., Anthony K., Ariel H., and Aislynn R.)
> Teacher: Linda Hamilton Grade: 1st and 2nd Ungraded
> Primary School: Hunters Woods Elementary
>
> Our thought process and answer:
> Miss H.: What do we know?
> David: There are 10 people all together.
> Alex: There are 9 guests.
> Stephanie: There is one of "you".
> Andy: You can only shake hands once with each person.
>
> Miss H.: What do we need to find out?
> Sebastian: How many handshakes are there by the time the last person shakes everybody's hand?
>
> Miss H.: How might we try to solve the problem?
> Aislynn: We could act it out.

(We acted it out.)
Katie: We got 45 handshakes in all.

Miss H.: Is there another way to check out the answer?
David: We could make a graph.
(We acted out the problem again keeping track of the number of handshakes each individual made and then graphing that.)

David: Now you have to count it all up.
(The class counted it out loud together with Jasmine pointing and leading.)
Andy: There were 45 in all...again!
Aislynn: That's the same as the last time!

Miss H.: Is there another way that we could have found out the number on the graph without counting it up one by one?
Aislynn: We could have added the numbers in the columns.
Miss H.: What numbers would those be?
Jasmine: 9+8+7+6+5+4+3+2+1=
Katie: ...45!

Miss H.: Does anyone see a pattern on the graph?
David: It keeps going down by one.

Miss H.: Can anyone make a prediction based on this graph?
(silence) Can you tell how many handshakes there would be if there were 11 people at the party?
Robin: The 11th person would have to make 10 handshakes so the total number would be...
David: ...55!

The answer to the original problem is 45.

The Teachers' and Students' Reactions

The Problem Solving Corner started slowly with only six entries the first week. By the tenth week, it was averaging well over 55 entries per week and has continued to grow. Students often finish their solutions by adding "This was fun!" Teachers are reporting great enthusiasm among their students. One first grade teacher described her students solving the following problem:

> Three neighborhood dogs barked consistently last night. Spot, Patches, and Lady began with a simultaneous bark at 11:00 PM Then Spot barked every 45 minutes, Patches barked every 8 minutes, and Lady barked every 12 minutes. Later that night Mr. Jones first awakened when all three dogs barked at once. What time did Mr. Jones wake up? Explain how you got your answer.

She wrote that her students decided to write down the names of the dogs and then write down all the times they barked until they came to a time when they all barked together. She related that "the lists were made...right through a fire drill during which the kids continued to mentally figure out the times and relate them to the teacher who recorded them on the fire drill clipboard! Upon returning to the building we transferred the lists to the chalkboard for all to see."

The ability of the curators to change the menus and structure of the pavilions themselves, without relying on a programmer, has enhanced the usability of the system greatly. The format of the Problem Solving Corner has evolved in response to comments and requests from teachers. The menu currently appears as:

Originally, problems and sample solutions were removed from the network after two weeks. However, teachers requested that the problems be archived, so that they were accessible at any time. A recent message has prompted further changes:

> Many of the teachers I work with have requested the 'answers'!!! to the weekly math problems that have been archived. Is it possible to add this?? They are practicing with the past problems and would love the answers. You know how teachers are - they hate to not have the answers!! Thanks!

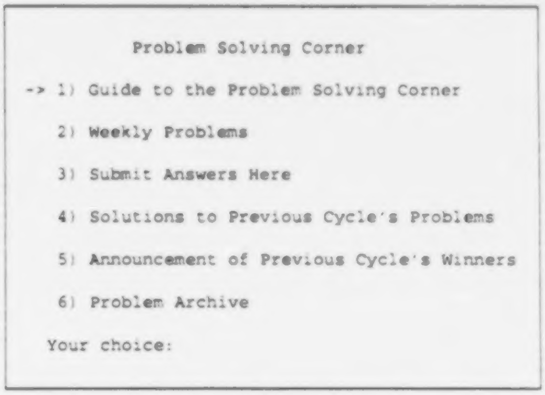
Support to the teachers is also vital. Although the system is quite user friendly, problems do occasionally occur. For example, one teacher kept disconnecting herself from the network in the middle of uploading her students' responses. One of our graduate students took her through the procedure step by step via e-mail, eliciting the following response from her:

> Dear Curator,
> I am assuming that you passed on my panic attack letter to someone at UVa. I got the nicest response from the man, and I was so excited to try that I don't even remember his name. I was really ready to give this up.

This teacher's class now submits at least one solution weekly and she is becoming comfortable using the network.

The Problem Solving Corner with Preservice Teachers

The Problem Solving Corner is used for much more than problem solving with K-12 students. It is an integral



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          Problem Solving Corner

-> 1) Guide to the Problem Solving Corner

   2) Weekly Problems

   3) Submit Answers Here

   4) Solutions to Previous Cycle's Problems

   5) Announcement of Previous Cycle's Winners

   6) Problem Archive

  Your choice:
```

Figure 1. The Problem Solving Corner Menu.

part of our teacher preparation program. After initial experiences in class, preservice teachers in their fourth year who are enrolled in the Reasoning Skills Block (i.e., elementary math, science, and social studies methods class) participate by solving the problems as if they were students and submitting their solution write-ups using the same format as the K-12 students. They can earn one point for an acceptable solution to a K-4 problem, two points for a 5-8 problem, and three points for a 9-12 problem. They are expected to earn a minimum of forty points during their first semester. Although approximately eighty percent of our preservice elementary teachers have had at least a calculus course, many of them find solving these problems, especially the 9-12 ones, difficult at first since they cannot just apply a formula. They are encouraged to work cooperatively, just as the K-12 students do, and over the course of the semester, become more confident in their abilities and more able to solve such problems.

One of the class assignments for these preservice teachers is the creation of a problem file. Once they have learned to distinguish good problems from mere exercises, each preservice teacher uses resources such as the *Arithmetic Teacher*, their clinical instructors, and teachers on the network to assemble a file of at least twenty "good" problems. They share their favorite problem from their file with their classmates via a discussion group on the network, and these problems are considered for future posting in the Problem Solving Corner.

Eventually, after they have become better problem solvers, learned how to communicate their thoughts by writing them in an organized fashion on the network, and learned to recognize good problems, these preservice teachers need to learn how real students approach solving problems. Some of this task can be accomplished face-to-face in their clinical placements, but the short amount of time available in these placements severely limits the amount that can be accomplished. To supplement the clinical experiences, the preservice teachers are each assigned to a particular teacher, look at the submitted solutions, and communicate with the students about their solutions. Initially, the preservice teachers often find it difficult not to just tell the students how to solve the problems, but they quickly discover that just telling them how to do it does not help them become better problem solvers; it just gets an answer quicker. The preservice teachers give hints, ask for more details, pose extensions, and converse with the students and the teachers about the problem solving process. Often solutions are submitted that are not quite what the preservice teachers or problem posers expected. For example, in solving the 9-12 problem:

> Professor Abstract's car license plate consists of a three-digit number. He challenges the class to find this number from the following clues. If you add 1 to the number, it is divisible by 7; if you add 4, it is divisible by 8; and if you add 7, it is divisible by 9. What is the number? Explain how you got this answer.

an eighth grader submitted 020 as his answer. After it was pointed out that 020 is generally considered a two-digit number, he replied:

> Earlier this week I submitted 020 as an answer to your 9-12 grade problem. The next day I received an reply to my submission that 020 is considered a two digit number; however, the problem specifically specifies the number as a license plate number and I realized that I had recently seen a license plate IQP-075, three letters and three digits, thus 020 is considered three license plate digits.
>
> Even though I strongly think that 020 should be considered as a correct answer, though not the one you expected, I have come up with another possible solution.
>
> Problem:
> n+1/7=integer
> n+4/8=integer
> n+7/9=integer
>
> Strategy:
> My new strategy was to plug the problem into a spreadsheet so I could process the mass amounts of data quickly and be organized while doing it. I figured out the multiples of 7 and subtracted 1 from each. I then added four to each and divided them all by 8. Next I eliminated the numbers that were not integers. Then I took the multiples of 7 minus 1 that had not been eliminated and added 7 to each and divided them by 9 and then I eliminated all that were not integers.
>
> Solution:
> I came up with 020 and 524 since you had told me that 020 was two digits I selected 524.

However, the eighth grader was not ready to concede. A week later he queried: "Do you agree that 020 is a legitimate answer?" This kind of dialog benefits the student as well as the preservice teacher, sharpening communication skills, problem solving skills, and logic. Additionally, the preservice teachers are interacting with real students and real teachers, not just trying to learn from a book or a professor.

Summary

The Problem Solving Corner is one effort to build an electronic community of learners. The teachers and students collaborate by sharing ideas, asking questions, and finding solutions to problems of mutual interest. The preservice teachers do learn a lot about mathematics and problem solving. Perhaps more importantly, they learn about how kids think mathematically. They also learn how to communicate with students and with other teachers on a professional level. It is only one type of communication and cooperation between the university and the public schools, benefiting the children, the preservice teachers, and the teachers.

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Jefferson By Topic: An Archiving Approach that Makes Retrieval Easy

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University of Virginia

An alternative method for storing information generated during electronic student to educational resource discussions has been implemented in the history forum on Virginia's Public Education Network (Virginia's PEN), Virginia's K-12 Internet network. The *Jefferson By Topic* approach allows student users to view information entered by other students and educators in an easy and meaningful way. The purpose of this project is to examine and implement an alternate approach to the standard annual archive process.

An increasing number of references to the potential K-12 instructional uses of the "national data highway" or Internet have recently appeared. A collaboration among the Thomas Jefferson Memorial Foundation (Monticello) Education Department, the Curry School of Education, and Virginia K-12 schools illustrates one potential use of this instructional technology, and some of the issues associated with the institutionalization and widespread use of such a project.

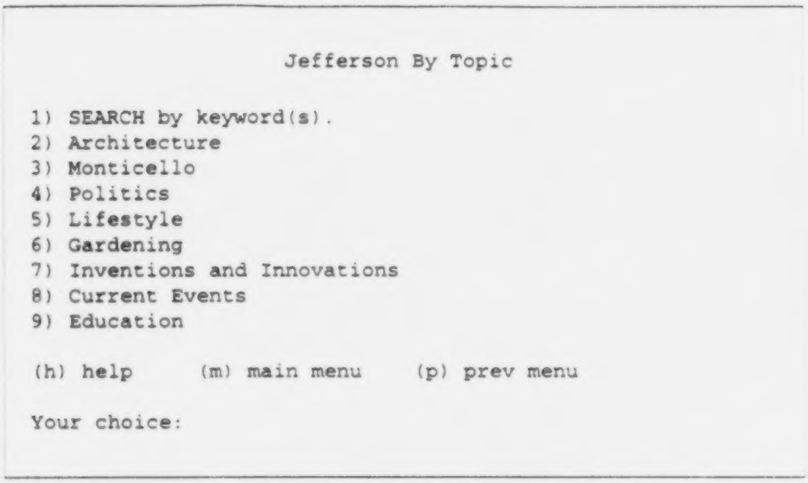
The Jefferson On-Line project was originally initiated by Judi Harris, then a doctoral student in the Curry School Instructional Technology program and Jennings Wagoner, a Curry School faculty member. Students posted electronic questions to Thomas Jefferson requesting information on a range of interests such as "what is your favorite vegetable" and "what influence did Rousseau have on your political thought." A response from the Curry School team in the guise of "Mr. Jefferson" was posted on an electronic conference in typical Jeffersonian style.

After the initial pilot demonstrated the feasibility of the concept, Jeradi Hochella, a subsequent doctoral student in the Instructional Technology program, collaborated with Robin Gabriel, Director of Education at Monticello, to transfer responsibility for ongoing maintenance of the project to Monticello. At the same time electronic location of the project was transferred to the history forum of Virginia's PEN.

As a result of this instructional initiative, Virginia's K-12 students are now conducting an ongoing electronic dialogue with Thomas Jefferson. Questions are, in actuality, responded to by researchers in the education department at Monticello. Questions and responses are posted on an Internet newsgroup (Jefferson On-Line) maintained on Virginia's PEN. Unlike a typical newsgroup, postings are deleted at the end of the academic year, rather than every few weeks.

The Jefferson On-Line newsgroup provides a permanent archive of past questions and responses. However, questions and responses are stored in chronological order. Therefore a student who wishes to review past responses about a specific topic such as gardening or the presidency may find this information intermingled with unrelated topics. Additionally, all responses include a copy of the question, resulting in the questions being put in the archive twice.

In the latest refinement of the Jefferson On-Line project, an archiving strategy was developed to implement an online database which groups information on similar topics in related locations. Categories or topics were selected based on two criteria: 1-the most common themes in the questions



```
                    Jefferson By Topic

1) SEARCH by keyword(s).
2) Architecture
3) Monticello
4) Politics
5) Lifestyle
6) Gardening
7) Inventions and Innovations
8) Current Events
9) Education

(h) help     (m) main menu     (p) prev menu

Your choice:
```

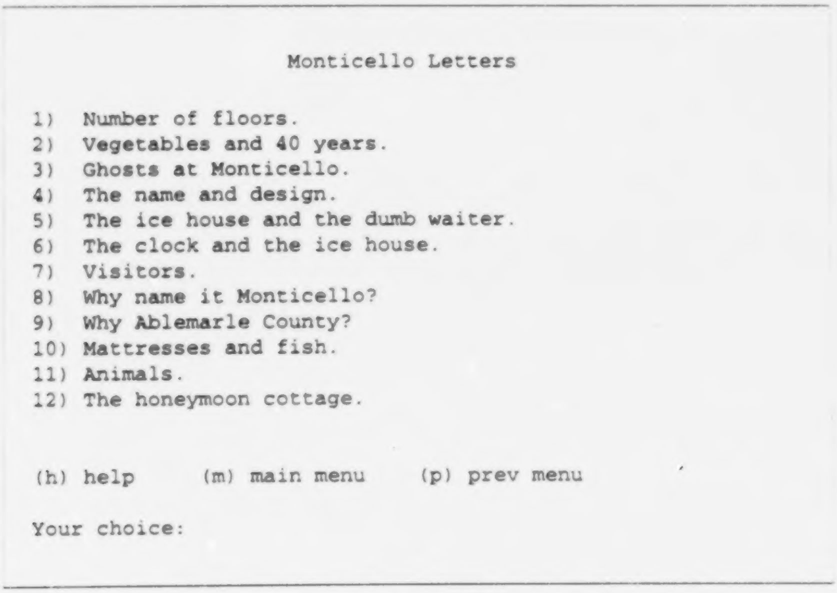
Figure 1. The Jefferson By Topic Menu.

and 2-the topics by which Thomas Jefferson is most well know by students; all existing archived responses were grouped accordingly. Using the *Jefferson By Topic* approach, a student is able to select from a list of topics and view the questions and responses in that topic only. Additionally, a search feature was added so that students can enter a word(s) and the system will find all questions and responses that contain that word and display them in a list. The student can then view the list and choose one or more items to view. The main menu for the solution is shown in Figure 1.

The Monticello topic menu (Monticello is a representative topic) is shown in Figure 2.

The following is a question and response that was archived in the Monticello topic: Monticello: Number of floors

>Dear Mr. Jefferson,
>
>How many floors did you have in your house at
>Monticello? What are your kid's names? How many rooms were >in your house?
>



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                    Monticello Letters

1)  Number of floors.
2)  Vegetables and 40 years.
3)  Ghosts at Monticello.
4)  The name and design.
5)  The ice house and the dumb waiter.
6)  The clock and the ice house.
7)  Visitors.
8)  Why name it Monticello?
9)  Why Ablemarle County?
10) Mattresses and fish.
11) Animals.
12) The honeymoon cottage.


(h) help     (m) main menu     (p) prev menu

Your choice:
```

Figure 2. The Monticello Topic Menu.

>We will be visiting Monticello soon.
>
>Sincerely,
>DAVID, ELLIOT, JACOB, PATRICK,
>& JEREMY
>
>Mrs. Y's fourth grade
>Burnley- Moran Elementary School
>

Dear David, Elliot, Jacob, Patrick and Jeremy,

Thank you for your letter. Monticello has always been a source of pride for me, I am glad that you are interested in knowing more about it. My house is made to look like it is one story from a distance. In actuality, it is four stories. There is the basement where the underground passage is located. There is the main floor where the entrance hall is located. And there are two stories above the main one that is used for bedroom space. The third floor (top floor) is where the dome room is located. It is a very pretty room that is painted a pale yellow and has lots of windows. My house has 43 rooms if you count all of the rooms in the dependencies like the kitchen and store rooms.

I have two daughters who have survived to adulthood. Their names are Martha and Mary. My wife, Martha, and I also had four children die in infancy or early childhood. It was very sad for us.

Sincerely,

Th. Jefferson

The online database of Jeffersonian responses is available in the resource section on the history forum which is part of the local archives on Virginia's PEN. Approval of the Thomas Jefferson Memorial Foundation was necessary in order to implement the *Jefferson By Topic* solution. A modeling approach was used in the development process. This allowed the client to approve and adjust the screens, menus, and features during development. The client was able to view actual screens and try them, resulting in a no-surprises final product that required minimal testing and approval time.

Each of the letters was read and placed into a category. Some crossed categories and were duplicated if necessary. After categorizing, a subject line was put on line one (example: Monticello: Number of floors.). This subject line becomes the displayed menu item when the letter is retrieved as a result of a student using the search feature. Each letter was then cut and pasted into the appropriate category (topic). After all letters were pasted, the search feature was added to the main menu and implemented.

Clearly much of the effort on this project was nontechnical in nature. At the end of each academic year the questions and responses for the year will be archived into one large file; again storing them in chronological order. Each letter must then be read and a subject line added and it must be cut and pasted into the appropriate topic. Documentation was written to insure that this process and product will be consistent from year to year (available on request). As the value of this and other alternate archiving strategies becomes obvious, it is likely that tools will be developed to automate these processes.

The product of this project is an approach that allows the student user to find and view previously entered information in a way that is either more meaningful (by topic) and/or more practical (by search). This information has been researched by staff and volunteers and can now serve double-duty by first answering the students questions and then by becoming part of a growing cache of readily available online information.

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Utilizing Gopher Technology in an Academic Environment

Cynthia Addison
University of Virginia

In the past 18 months, gopher technology has emerged as the penultimate tool for archival storage of information on the Internet, and most universities have now established their own gophers. The challenge now is to acquaint the larger academic community with uses of gophers for purposes such as establishment of Campus-Wide Information Systems (CWIS). While many students and faculty have mastered electronic mail technology, fewer have yet taken advantage of this emerging technology which could greatly facilitate information dissemination. Like all technological improvements, the keys to user participation are well developed ideas for utilization, adequately documented instructions and a strong public relations campaign that alerts student and faculty to the new technology.

Goals of the Project

This project is one of several concurrent efforts designed to provide academic and technologic leaders within the University community with exposure to gopher technologies. This particular initiative has the University's Academic Computing Advisory Committee as its focus. The goals of the project are to:

1) Establish a space within the University Campus-Wide Information System for communication of information regarding the deliberations of the Academic Computing Advisory Committee,
2) Ensure that each member of the Academic Computing Advisory Committee has appropriate gopher software correctly installed on their personal microcomputer or workstation,
3) To provide members of the committee with training and follow-up support in the use of this software, and
4) To institutionalize the process of maintaining the Academic Computing Advisory Committee section of the Campus-Wide Information Server.

Project Narrative

The University of Virginia information technology committee on academic matters, known as the Academic Computing Advisory Committee (ACAC), includes representatives from each of the University's schools, the library, and three members from the College of Arts and Sciences representing natural sciences, social sciences, and the humanities respectively. The ACAC has established two electronic communications channels to foster increased communication with the University community:

(1) a local USENET newsgroup for interactive discussions, and
(2) a section on the Grounds-Wide Information Server.

These electronic forums will be used by the Academic Computing Advisory Committee to invite comments on various policy issues - for example: how to best provide computer classrooms, high-performance computing needs, and strengths and weaknesses of current computer support services, and to report committee deliberations. These steps are intended to promote interactive discussions among members of the committee, the computing committees of the respective schools and the college, computing center staff, and the general University community. The ACAC section on the Campus-Wide Information Server (found under the "Computing and Communications" section) will provide a space for archival storage of documents associated with the committee, such as committee minutes, academic computing plans of schools and departments, and other documents relevant to the committee's deliberations.

Project Deliberation

We began the project by alerting all ACAC members of the creation of the gopher and the USENET newsgroup to facilitate discussion. Members were asked to request assistance if they were not already able to access the university mail and gopher, and they were assisted in their efforts to get connected. In this process, we found the need to write up specific instructions for faculty members and to create batch files where necessary to facilitate hook up.

The gopher site was subsequently created, and this aspect of the project manifested some crucial concerns. Designing the menu became our next focus. In this process, it was important to keep the ACAC menu uniform with the other menus on the Grounds Wide Information Server (GWIS). It was placed under the Computing and Communications Menu and began with an "About This Gopher" item. Following this entry were the bimonthly minutes and an electronic copy of each of the department's technology plans.

The intent of the gopher installation and the newsgroup was to facilitate information transfer between the ACAC and the academic community at large, and we tried to keep this in mind as we developed this service. We were especially interested in motivating committee members to use this technology. To this end, we displayed a copy of the RFP for the annual funding technology grant which the ACAC administers on the gopher. It was our hope to enable department heads to download the request if they did not receive it in a timely fashion from their deans.

With this same spirit of communication in mind, the committee displayed the various department's technology plans on the gopher so that members could look through the plans while they reviewed the requests for funding. It was a prerequisite of the grant that a department applying have a plan in place with the ACAC, and the gopher assisted in the distribution of these plans to the community at large.

It was our hope that having this service available would cut down on the need to photocopy the lengthy technology plans for all the members of the reviewing committee. However, these intentions were unfulfilled in the first semester of the project because problems with electronic transfer of the text hindered uploading. As this is a work in progress, we hope to continue to facilitate this transfer of data throughout the year.

One of the essential elements of this project is the concentration on long-term upkeep of the ACAC gopher menu. It is important to the committee that the information on the gopher be kept current and that future curators are able to build on the initial findings of the committee. To that end, an instruction "tip sheet" was developed to assist with gopher maintenance. Other information sheets were developed to aid users including specific instructions for uploading formatted text.

This project is still in process, and we hope to study these user interface questions in more detail in the upcoming months. As a final outcome, we hope to draft some concise results from and suggestions for utilizing gopher technology more effectively in the academic environment.

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Teaching Hands-On Science With Fully Interactive Distance Education Technology

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Technology and teacher education have been linked for many purposes in a variety of venues. This paper describes a semester-long, fully interactive hands-on science course for elementary teachers. For this class, a two-way audio/two-way visual signal was broadcast between a studio at Indiana University-Bloomington and three urban elementary schools in Indianapolis (over 60 miles away). This allowed teachers enrolled in the class at any of the school sites to see and hear class instructors. Furthermore, participants at each school site could fully communicate with the instructors and teachers at other school sites. A review of the literature (Barker, 1987; Tresman, Thomas, and Pindar, 1988; Chow, 1989; Charron and Obbink, 1993) suggests that such a fully interactive, hands-on course has not been previously offered using this technology for teacher education. Throughout this paper "instructors" refers to the two faculty members leading the class in Bloomington, while "teachers" indicates those who are active elementary teachers.

The Technology

The technology used to deliver the course consisted of special units designed by RCA-Thompson to project, record, and transmit the interactive, two-way signals. These school units include: 1) an echo canceler to reduce feedback, 2) a 52" rear projection television, 3) cameraman camera control (which allows for the movement of a camera on 3-axes), 4) remote control, 5) an infrared controlled camcorder, 6) microphones, and 7) a moveable cart with i) a graphics stand that can support overheads, ii) an electronic chalkboard, iii) a VCR, iv) a laser disc player, v) a PC with graphics display, vi) a CD-ROM, and vii) a telestrator. This site equipment is an expansion of RCA's Genius Theater. The design goal for these units was to develop a single device which could serve all of a school's multimedia needs.

General Format of the Course

In order to interpret the results of the data collection reported later in this study, it is important to provide an overview of the steps taken during a typical hands-on science distance education broadcast. Although the formal broadcast usually began at 4:30 PM every Tuesday, the two instructors of the class would usually arrive at the television studio 30 minutes prior to broadcast time. During the period preceding the broadcast, wireless microphones would be strapped on, sound levels checked, and furniture moved about to facilitate the demonstration of hands-on science. During this preparation time, the studio engineers would check all of the audio and video connections from Bloomington to Indianapolis. A small earpiece was worn by both of the instructors which enabled the studio engineers to communicate with the instructors. A final step taken to prepare for each class included the writing of short text which could be displayed electronically on the television screen. Each lesson followed a similar general prebroadcast format.

As each broadcast began, all schools would be brought on line, and audio and video quality assessed. Following this step, each site (one by one) would be projected for all of the other sites to see and hear. At this point, teachers could ask questions of any sort. The queries involved a wide range of issues, from comments involving the technology to questions pertaining to assignments. This step usually took 15 to 20 minutes of class time.

The next segment of the class usually consisted of three teachers (one at each school site) sharing their application of the previous week's lesson. The reason for this activity was to encourage the teachers to apply all class activities. Often, participants would use the graphics stand to show added material they had developed. As an alternative to using the graphics stand, some would simply approach the camcorder situated atop each Genius Theater.

Following this segment, the two course instructors would present a brief introduction to one hands-on science topic. This introduction would be followed by an activity in which all of the participants at each site would actively complete a hands on "lab." These labs ranged from dissecting a chocolate chip cookie (in order to evaluate the pros and cons of mining), to constructing simple electric circuits with aluminum foil wires. During each broadcast, the instructors would view all the sites to facilitate the labs. The instructors found that although they were not physically present in the class rooms, the large screen television's clear image allowed communication with teachers almost as well if they were present at each site. Usually, lab activities would end approximately 15 minutes before signoff whereupon teachers at each site would be reminded what homework was due the following week, what materials should be brought to class, and who would be presenting.

Success and Failure of Science Education Topics Using Interactive Technology

Utilizing distance education for the presentation of truly interactive teacher education courses can facilitate convenient classes for active teachers. So that the instructors of the class could learn about teachers' reactions to the use of this technology and the interplay between topics and technology, a number of attitudinal surveys were administered to those teachers enrolled in the course. The four administered surveys included 1) open-ended comments regarding class content and technology, 2) rank ordering of class topics in terms of helpfulness, 3) an evaluation of the instructors and 4) completion of a 34 item distance education technology survey. Although the total enrollment in this course was relatively small (16 teachers), the reviews provide important insight into the important issues of distance education and teacher inservice.

The Interplay of Technology and Hands-on Instruction of Science

The open ended survey presented to these teachers involved seven questions: In terms of this interactive course, what 1) should stay the same, 2) should be improved, 3) should be added, 4) should be removed, 5) worked, 6) did not work, 7) would you change?

The teachers (all of whom taught elementary school) liked the length of each broadcast (2 hours once per week), the constant interaction between the studio based instructors and the school sites, the ability to involve every participant with all of the experiments, and the ability to see all of the experiments so well with the aid of the large screen television. In summary, these teachers, indicated it was indeed possible to present hands-on science through interactive television.

Some of the teachers' complaints were 1) although the interaction was excellent between each school site and the studio, the other schools could often not clearly hear the sites in direct communication with the studio; 2) the teachers enjoyed being able to have two locations displayed on the big screen television at one time, however, they would have preferred to have all of the school sites simultaneously displayed; 3) a person was needed at each site who could fully operate the equipment; 4) there was no way of signalling the studio that a particular site wished to ask a question.

These comments reveal some difficulties in presenting hands-on science through interactive distance education. A key to a successful lesson is that there be high quality video and audio connections between all of the school sites and the broadcast studio. If either the audio or video link fails, it is exceedingly easy for the teachers to feel disconnected from the rest of the class. Clearly, when the only link between all of the teachers and the instructors is an electronic tether, no part of the connection must be severed. Other issues that the comments illuminated are that these teachers want added technology to improve class interactivity. In essence, these teachers requested devices which would allow them to have the same sort of communication possible in a normal, everyday classroom.

A few of the open-ended comments supplied by teachers seem to fall neither in the complaint category nor the compliment category: 1) Use all of the supplies required for each broadcast; 2) Determine whether or not the textbook was really needed; 3) Increase the number of sessions during which participants would all meet as one group; 4) Organize the timing of each broadcast better; and 5) Include on-site registration at the first meeting. These comments could be influenced by a number of factors. Teachers were often required to bring supplies for the day's lesson (quite different than the typical college course in which most of the supplies would be provided), but sometimes the instructors would not complete all of a planned lesson which in turn meant that not all of the supplies would be utilized. One reason for the misjudgment of time needed for each lesson was the fact that the instructors were never sure how well each lab might work using the distance education technology, so they overplanned.

Other teacher comments involved the sparse use of the required text. This comment is probably a function of the fact that this course had never before been produced. Since the instructors were not sure how well the distribution of materials (through the mail and by car) might work, they believed a good backup position involved required purchase

BEST COPY AVAILABLE

Table 1
List of Science Topics Presented to Teachers

Electricity	4.57	Plants	4.64
Energy/Heat	5.07	Ecology	5.36
Earth	6.21	Misconcept	6.79
Animals	7.29	Weather	7.50
Magnets	7.86	Ice Breaker	8.21
SpaceGravity	9.71	Learning Cycle	10.50
Grab Bag	11.10	Humans	11.75
Museum Science	12.50		

Note. Those topics at the top of the list were ranked as being among the best topics, while those at the base of the list were ranked as being the least helpful.

of a text presenting hands-on science labs.

Finally, on-site registration was suggested by nearly all of the class participants. In retrospect, this makes sense. Since the appeal of distance education for many teachers is the ability to drive to a local school, park easily, attend class, and drive quickly home, it seems reasonable to remove a trip these teachers might make for class registration.

Results of Topic Ranking

During this course, the K-6 teachers were exposed to 15 science topics. Some of these topics were well-received by teachers, while others were viewed in a less favorable manner. Table 1 presents the order in which the topics were ranked in terms of "helpfulness" for teachers. Because the sample set is small, slight differences in rankings are probably not significant, but these data do begin to provide a clearer picture of those topics that were not only helpful to these elementary teachers, but also those topics that were successfully presented using the distance education technology.

The lesson involving museum science was presented by two experienced guest instructors who have had great success in working with elementary teachers; however, these two individuals had not previously utilized this technology. This might explain this low topic ranking. The low ranking of "humans" may be related to two factors. Elementary teachers are usually quite familiar with some aspect of this topic, while they may not be well-versed in the topics such as electricity and magnetism. Thus, they might view this as a redundant topic. A second possibility for the low rating is that the "human" lesson did not include a lengthy hands-on lab. This activity may have been rated in a low manner because of subject matter and not a technology problem.

The Learning Cycle was another lesson that was not highly rated by the teachers. This lesson was also taught by a guest lecturer. The instructors of the class suspect that this low rating might be related to the lesson having been something these teachers did not find as useful as the other activities. This might be related to the topic's involving a teaching technique as opposed to subject material. It should be pointed out that this lesson took place when all the teachers met at one common site. Conceivably some teachers gave this lesson a low rating because some had to travel to an unfamiliar school site across town.

There are other factors which may have influenced the ratings of topics. The activities that received low ratings seem to have been those for which either added materials were brought and not used or those lessons in which too many activities were carried out during one session. Finally, it must be mentioned that because the evaluation used a "ranking" scale (as opposed to a "rating" scale), the data presented in Table 1 show only an ordering of class topics, not a rating.

Teachers' Ratings of the Instructors

Teachers attending this class were asked to also provide a number of ratings with regard to the course structure and the university professors. Each question in the survey could be rated using a four-step scale of strongly agree (4 points), agree (3 points), disagree (2 points), or strongly disagree (1 point). Table 2 presents the average ratings for statements pertaining to the course, while Table 3 displays the average ratings for statements involving the instructors.

Table 2 reveals that those teachers responding to this survey gave ratings that were on average between "strongly agree" and "agree." The lowest rated statements involved the organization of the course and the stating of course objectives. These ratings may have resulted for a number of reasons. Since this course had never before been offered, the

Table 2
Average Ratings for Statements Pertaining to the Course

The course is well organized	3.64
The objectives of the course are clearly stated	3.64
Course assignments help in the learning of subject matter	3.71
The grading procedures for this course are fair	3.86

Table 3
Average Ratings for Statements Involving Instructors

My instructor stimulates my thinking	3.86
My instructor is fair and impartial in dealing with teachers enrolled in this class	3.86
My instructor promotes an atmosphere conductive to learning	3.3
My instructor uses teaching methods well suited to the course	4.00
My instructor is well prepared for class meetings	4.00

organization of the course did change during the semester. Another factor could be related to sites' occasionally experiencing technical difficulties either in transmitting or receiving broadcast signals; the teachers may have viewed this glitch as a poorly organized aspect of the class. Yet another influence may be teachers' frustration with lessons that did not use all of the "teacher-bought" materials. As in any course, a class must be well-organized and the class objectives clearly stated. It seems, however, that for those classes which are targeted at active teachers and also utilize interactive distance education technology, it is of tantamount importance that these two issues are confronted. For future courses, the instructors will stress the class objectives more often. A second change will be an increased availability of on-site materials (which teachers will not have to supply). This should decrease the frustration level of teachers when materials are not completely used if a lesson is not fully completed.

The five statements rated by the teachers indicated a very positive attitude of teachers toward the instructors. However, the most heartening and important aspect of these ratings was that all of the teachers felt the instructors' teaching methods were well-suited for this course. This high average value seems to indicate that hands-on science teacher education classes can indeed be taught utilizing interactive technology.

Results of Distance Education Survey

A fourth evaluation instrument was presented to participating teachers. This instrument consisted of 34 rating scale items that involved issues of distance education technology and teacher inservice. This rating scale also utilized the same four-step scale which was used in the previously discussed instrument (strongly agree, 4 points; agree, 3 points; disagree, 2 points; strongly disagree, 1 point). The results of this data collection are presented in Table 4. In general, the set of 34 statements answered by class participants seems to verify the trends noted in the other surveys. These items indicated that teachers felt this was a useful technology and that they might continue to use it on their own with students. Furthermore, participating teachers' responses seem to suggest that they did not feel they learned any less than in a traditional course. From a technology and teacher education perspective, the most important response may be the very supportive ratings given to survey item #4 (Being able to choose from a number of sites for class attendance was an asset of this type of class). By using technology, classes may be made more appealing simply by increasing convenience.

Conclusion

Distance education has been utilized in teacher education in a number of ways. This paper outlines teachers' attitudes toward a fully interactive hands-on science class that was broadcast to three schools from a university studio. In general, teachers felt that the course was convenient and as useful as a traditional class. However, attitudinal data suggests that improvements in the technology should be made to enhance the interactivity during broadcasts.

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Table 4
Rating Scale Items Involving Use of Technology and Distance Education

Item	Rating	Statement
18)	1.14	In general, the instructors made good use of the television and audio technology.
4)	1.14	Being able to choose from a number of sites for class attendance was an asset of this type of class (television and audio).
26)	1.38	If I were a high school teacher I would use this type of technology to link up to other schools.
27)	1.38	If I were a middle school teacher I would use this type of technology to link up to other schools.
1)	1.42	In general the instructors were able to make good use of the t.v. and audio technology, so the course quality did not suffer.
28)	1.46	If I were a elementary school teacher I would use this type of technology to link up to other schools.
12)	1.50	Interactive audio (as opposed to one-way talking heads) that connects all sites is needed to teach such a class.
22)	1.54	The interest of the instructors in this type of class could be detected just as easily as if one was in a traditional class.
31)	1.54	The objectives of a class can be achieved using this television and audio technology just as easily as in a traditional class.
13)	1.57	Interactive television (as opposed to one-way talking heads) that connects all sites is needed to teach such a class.
2)	1.64	The t.v. and audio tech. allowed as much interaction between the instructors and teachers as found in a traditional course.
17)	1.64	Teachers could hear instructor's questions as easily as in a traditional class setting.
20)	1.64	This t.v. and audio class allows the same variety of teaching techniques to be used as is possible in a traditional class.
25)	1.69	Being able to meet together with other teachers is very important for a class that will rely on television and audio.
7)	1.71	The use of t.v. and audio technology meant that this class was conducted in a more informal atmosphere than a traditional class.
24)	1.77	Attending a class like this allowed me to learn about the use of technology.
14)	1.79	Visuals (slides, overheads) broadcast through the network were more useful than they would be in a traditional class.
11)	1.92	The quality of the television picture in class did **not** lessen the quality of the course.
6)	2.00	The technology of this class allowed students to be exposed to topics which would not normally be available for a traditional class.
15)	2.07	Instructors could hear teacher's questions as easily as in a traditional class.
34)	2.31	Group learning is not more difficult to carry out with this technology.
19)	2.43	Being able to see other sites on a video screen at the same time would be very important for the success of such a class.
3)	2.43	A course based on this use of t.v. and audio should have a person at **each** site to answer questions.
33)	2.62	When problems in the televised image or the audio quality occurred, the problems were quickly fixed.
10)	2.64	The quality of audio in class did **not** lessen the quality of the course.
9)	2.69	It is more difficult to distribute readings to a television and audio based class than to a traditional class.
16)	2.86	Teachers could hear other student questions at other sites, as easily as students in a traditional class can hear questions.
21)	3.07	The set up of rooms was a hindrance to the use of audio and television in this type of class.
5)	3.29	Each class session covered less material than a similar class in a traditional format (teacher and students in one room).
30)	3.31	For classes using this technology, in general, it will be more difficult to assign students a grade.
32)	3.31	The use of textbooks is **more** important in this type of class than in a traditional class.
8)	3.43	The use of television and audio technology will mean that classes are more impersonal than traditional classes.
23)	3.46	The use of television and audio makes class participants feel more disconnected than in a traditional class.
29)	3.62	The use of television and audio (as used in this course) will just be a fad like educational television.

Note: Average rating given by the responding teachers. Strongly agree is a 4, agree is a 3, disagree is a 2, and strongly disagree is a 1.

Project MentorNet

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This paper is divided into two parts. In the first part, the development and implementation of MentorNet will be described. In this section the logistics of giving students access to limited modems (3) and setting up the bulletin board/e-mail system will also be emphasized. The second section of the paper addresses the preservice/inservice training necessary to implement the program elsewhere.

The Problem

Every year tenth grade biology students in the Science Academy conduct independent research projects. Involving community members as mentors of students projects lends significance to the project as well as providing an outside source of information. However, getting students and mentors together is difficult, given scheduling constraints and lack of student transportation. Using e-mail allows mentors to review student work at their convenience and permits students to receive effective feedback in a timely manner. Another difficulty with student research projects is a dearth of high-level library resources available at the high school level. Using Internet resources like Gopher, Veronica, and telnet allows students to access information that is otherwise unavailable to them.

With computers and modems; word processing, statistical, and communications software; and Internet, teachers have the potential to direct high-level research assignments without their students having to leave the high school facility. However, to date no procedure has proven effective in allowing the teacher to manage diverse research projects carried on via modem through Internet. Community mentors for individual students promise a solution to this problem.

The Logistics

Potential mentors must be identified before the project begins, the number depending on the number of research groups and the amount of time mentors are willing to dedicate to the project. However, one mentor for each group of students or for a few groups of students is recommended. There are several ways to enlist mentors. At the Science Academy, we contacted key professors at a local university and formed an alliance with a department. We also posted notices in newsgroups on the Internet. While the Internet response was sparse, we did get a few mentors from responses to postings in the Kidsnet (Kidsphere) newsgroup. If you choose to use Internet postings, allow ample time to recruit mentors. After mentors are identified, have students begin work on their projects. Figure 1 shows a brief outline of how the plan works.

The student phase of the project begins with students using the Internet (specifically Gopher, Veronica, ftp, and telnet) to gather current background information on their research topic. After students have gathered adequate information, they write research proposals or plans consisting of background information, a hypothesis, and a suggested procedure. The teacher reviews the proposals, and, based on the students' research interests, then assigns mentors to students. Once the mentors have been assigned, students begin correspondence by sending their proposals to the mentors for review. The degree of interaction between the students and their mentors during the rest of the project will depend on the size and complexity of the research topic, the student's abilities and learning style, and the mentor's teaching style.

At the Science Academy, there are only three modems available for student use. It is therefore imperative that students do most of their writing on a word-processor off-line, save the documents as ASCII files, and then upload their work into their Internet accounts. As long as there are other classroom activities that students can do, the students can rotate onto the modems and upload their files. We have also occasionally set time limits on the modems to ensure that all students have access.

Evaluation of each research project involves assessment by peers, mentors, and teachers. The project is graded on a credit/no credit system based on overall quality. As follow-up activities, students anonymously post their final papers in a newsgroup for peer review, inviting other students to read the papers online and to comment on the research.

Training Needs

The type of training that is necessary to implement a MentorNet project varies somewhat with the available technology. In Texas, for example, teachers have full Internet access through a statewide education network called TENET. Since very few states offer full Internet access to teachers, the type of training may be modified based on the type of access available. In this section, I will assume there is full access since those with less access can merely scale down the training to fit their needs.

The keystone skills required for a successful MentorNet project are facility with e-mail and newsgroups (bulletin boards). These skills can be well taught to novice computer users in a four-hour workshop. This workshop should include the following skills: sending e-mail, composing e-mail, reading files into e-mail, exporting files from e-mail to a home directory where they can be downloaded, accessing newsgroups, moving around in newsgroups (i.e., selecting and opening files), posting follow-up comments and replies to articles, posting articles, and saving articles to files.

In addition to e-mail and newsgroup skills, teachers should learn how to upload and download files. While these skills are not absolutely necessary for the program, facility with them will reduce online time and redundant typing of revisions by students. Furthermore, off-line word processors are usually more user-friendly than online word processors. A four hour workshop on file transfer could include uploading and downloading ASCII files, uploading and downloading binary files, and a little about file encryption and unencryption. Encryption programs like BinHex allow users to send formatted documents and pictures through Internet accounts. Without encryption, students will be limited to ASCII text format for their documents.

In order for students to make maximum use of Internet resources, teachers should receive training in gopher, telnet, WAIS, ftp, Archie, and Veronica. These tools allow Internet users to find current information about almost any topic. Gopher and Veronica are the simplest of these tools and can be taught in a four-hour workshop. Judi Harris, author of *The Computing Teacher* column "Mining the Internet," teaches gopher skills to her students through a scavenger hunt. First students search the University of Minnesota gopher or the TENET gopher and then each student posts two scavenger hunt questions in a newsgroup on TENET. Students are then required to use gopher and

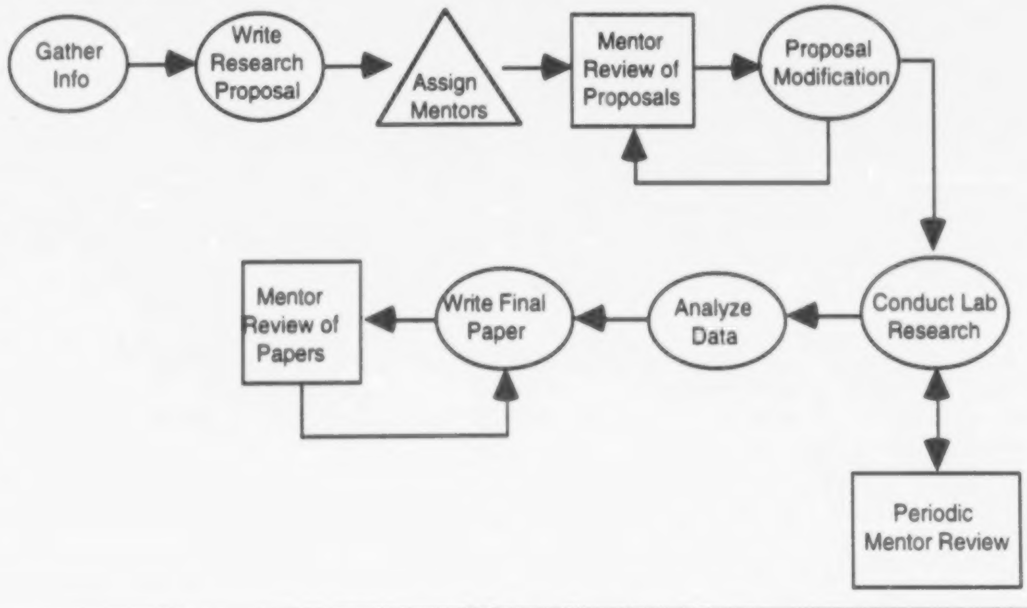

Figure 1. MentorNet Flow Chart.

Veronica find the answers to at least two of their classmates' questions. Telnet is also a relatively easy skill and can be taught in a four hour workshop. Actually, the skills required to telnet take only a few minutes to teach, so most of the workshop should focus on allowing participants to explore various telnet sites. Ftp is a much more complex skill and requires at least two four-hour workshops for participants to develop minimal competency.

In addition to workshops, the truly adventurous can pick up many of these skills via books on the Internet. For the novice computer user, *The Internet Companion* (LaQuey, 1993) offers simple instructions for most of the previously mentioned skills and is written in everyday English. For more advanced users, or those who want more information, *The Whole Internet Catalog* (Krol, 1992) provides more advanced instructions and also gives a larger list of Internet resources in its appendices. Teachers in Texas may want to obtain a copy of the *TENET Users Manual*. This manual is not as easy to understand as *The Internet Companion*, but it does provide instructions for nearly all the services available on the Internet and it provides appendices with information about listservs, telnet sites, and ftp sites. Another source of information about the Internet, is the Mining the Internet column written by Judi Harris in *The Computing Teacher*. In this column, Dr. Harris provides her readers with information about the latest Internet resources and instructions on how to access these resources.

Optimally, teachers should also learn how to set up and maintain their own e-mail and bulletin board systems. For the cost of a high speed line (about $300/ month), a computer with a large hard drive and a router, an Internet node can be established. An Internet node is a computer with a specific Internet address. If you're like most of us, your computer at home does not have its own Internet address, but you have an address (or account) on a remote computer which does have an Internet address. Why is this important? A node can store files that are accessible to anyone on the Internet (e.g., ftp archives, gopher files, and e-mail accounts). The advantage of having one's own node is that students can have their own individual accounts on the Internet through the node computer. The cost of individual student accounts on a remote node can be very expensive. Individual student accounts also provide some student accountability and greatly increase student access to the Internet. A school node also provides the school with some excellent learning opportunities that are unavailable if the school is not a node. For example, one high school has established a gopher server that presents information that students have collected to any Internet user who telnets to that high school.

Aside from the cost, the disadvantage of being a node is upkeep. Not all school districts have trained personnel available to run such systems, so teachers are often left maintaining hardware and software. Basic training in setting up and maintaining simple e-mail readers and bulletin-board systems wouid allow interested teachers to pursue establishing Internet nodes and help them keep the node going after the inevitable hardware or software crash.

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Extending the Reach of Teachers Beyond the Classroom: Exploring PBS *Learning Link*

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Learning Link is a public television sponsored, computer-based telecommunications and information network developed for K-12 teachers. In its broader context, *Learning Link* is actually a network of geographically distributed localized systems that permits educators to access information, exchange messages, and share resources with colleagues nationwide. Currently, there are approximately twenty-four *Learning Link* access providers located throughout the United States (all PBS affiliates), and a central host is available to those educators who do not have access to a local system. Although each provider offers the same basic "core of services," other specific offerings will vary from "site to site" and, perhaps, region to region. Accordingly, this document focuses on the common, general capabilities of *Learning Link* sites nationwide, however, specific details for accessing the general functions discussed herein can be found in the User's Guide developed and distributed by each *Learning Link* site system administrator.

In constructing *Learning Link*, Public Broadcasting Service (PBS) ONLINE chose to de-emphasize the technology itself and instead, focused on how educators could apply its resources as vehicles for enhancing classroom instruction. Moreover, its premise holds that

> Teachers and students, rather than technology, are at the heart of the user-friendly system. As a result, PBS *Learning Link* subscribers become part of a unique national community where diverse geographical and cultural backgrounds offer a learning environment where beliefs are challenged, stereotypes questioned, and values enriched. (Public Broadcasting Service, n.d.a, p. 1.1)

In creating and sustaining that unique instructional environment, Learning Link subscribers can employ the following general resources:

- Electronic mail and conferencing capabilities
- Interactive databases
- Forums
- Discussion centers
- Newsgroups

Learning Link at a Glance

One of the advantages of accessing educational resources online is their on-demand availability. To that end, *Learning Link* is available 24 hours a day, seven days a week year round. All that is needed to get started is a personal computer, a modem, a telephone line, and a communications software package (e.g., Kermit, Procomm, White Knight, Red Ryder, ZTerm, etc.). Learning Link supports modem baud rates from 300 to 14,400 bits per second (bps), and it is accessible from virtually any location (assuming, of course, the equipment noted above is available). In most cases, system access is unlimited, however, some local site administrators may restrict connection times to 60 minutes when heavy access demands inhibit reasonable system availability to other *Learning Link* subscribers.

Electronic Mail

One of the most exciting features of *Learning Link* is the capability for users to send and receive electronic mail (e-mail) right from their personal computers. *Learning Link* subscribers can exchange e-mail with other users on their *Learning Link* node, with other users on other *Learning Link* nodes, and with anyone (worldwide) for whom they have an Internet address. Although to do this, they will need to know the e-mail address of the person with whom they are corresponding.

E-mail addresses take the general form of *userid@domain-name* where *domain-name* identifies the exact Internet host (computer) on which the recipient of an e-mail message has a registered account while the *userid* is the name the recipient uses to log onto that host. Accordingly, no two users with the same domain-name can have the same userid just as no two houses on the same street can have the same house numbers. The Internet address *spurcell@llwhro.ll.pbs.org* breaks down like this: "spurcell" is my *userid* and "llwhro.ll.pbs.org" is my *domain-name*. Therefore, if *Learning Link* subscribers want to send me e-mail, then they would address it to my *userid* at (hence, the "@" symbol) my domain-name. What if you do not know the e-mail address of the person with whom you want to correspond? The quickest (and most direct) solution is to simply call that person on the telephone and ask!

Interactive Databases

The Curriculum Connection is an interactive database which manages information about instructional television programming, a learning tool designed specifically for classroom use. Instructional Television "introduces students to people, places, and events; aids in the instruction of basic skills; and illustrates difficult concepts with sophisticated animation and photography" (Public Broadcasting Service, n.d.b). Using the database, teachers and media specialists can not only coordinate daily classroom events with Instructional Television resources, but they can integrate interdisciplinary programs that examine subjects from alternative points of view.

The Curriculum Connection permits *Learning Link* subscribers to search a wide variety of programs, and it also assists in identifying specific episodes from Instructional Television series titles. In conducting a search, users first define the search criteria by selecting and defining the parameters from different categories. These categories include subject, keyword(s), educational level, series title, episode title, producer, and distributor. By supplying information about one or more of these categories, users can tailor their searches to meet their own specific curricular needs. For example, consider the following scenario: a seventh-grade science teacher plans a lesson on common bugs and wants to determine available video resources to supplement (as well as enhance) her instruction. By querying the Curriculum Connection, she makes the determination easily and quickly. In this case, she enters "insect" as the subject and "G7" (seventh grade) as the educational level. The database then retrieves and displays, screen-by-screen, the set of instructional program titles about insects developed for a seventh-grade audience. By adding additional criteria, the search can be narrowed to a specific series, episode title, distributor, or producer.

Forums

Forums are "places" where educators can share information and ideas on a wide variety of topics with their colleagues. Some forums serve as simple bulletin boards (areas where items can be posted and viewed by any *Learning Link* subscriber) while others offer extensive text resources and file libraries. File libraries are repositories for both text documents and computer programs, and *Learning Link* subscribers can download these files to their personal computers as well as upload files to share with their colleagues. Many of the computer programs are shareware, so *Learning Link* subscribers who use these files are bound by their honor to register their ownership with the programs' authors, and often, this means paying a fee as well.

In general, forums are added and deleted on a regular basis by each *Learning Link* node's system administrator. While not all *Learning Link* administrators "post" all forums, they do provide access to many of the following ones. These include, but are not limited to, forums on:

- Art
- The American Experience
- Arctic/Antarctica
- Behind the Scenes
- Election Central
- Environment
- Childhood and Kidlink
- Columbus/Age of Discovery
- College Knowledge Center
- Copyright and Schools
- Newton's Apple
- NCREL Restructuring Teleseries
- Quality or Else
- Scientific American Frontiers Online
- SIECUS
- Television for Learning
- What's in the News
- Weather in the World
- The Mexico Project
- American Express Geography Expedition
- Africatrek
- CTW Ghostwriter Teacher's Guide
- Challenger Center Space Forum
- National Teacher Training Institute Forum

Discussion Centers

Discussion Centers, conceptually, are "electronic rooms" where people with similar interests "gather" to exchange ideas and share information on a particular topic. While both electronic mail and bulletin boards also foster communication between *Learning Link* subscribers, they actually serve different purposes; electronic mail is used for exchanging *confidential* (not publicly accessible) correspondence between subscribers whereas bulletin boards promote only one-way exchange of communications (e.g., posting announcements, position vacancies, schedule changes, etc.). Discussions, on the other hand, are electronic messages written and read by *all* people sharing an interest on a particular topic.

In any given discussion, there are two types of messages—those that start a topic and those that either reply to a topic or reply to somebody else's reply. Each topic has a name that describes its focus so that replies can be grouped according to the topic or theme to which they pertain. In addition, a discussion may generate more than one topic. For example, a technology discussion center could accommodate topics relating to, among others, hardware, software development, ethics, troubleshooting, and networking. Once inside the technology discussion center, users may reply to any of the ongoing technology-focused topics, or they could initiate their own, new theme.

Additionally, each discussion center employs a manager (or moderator) who maintains the integrity of the topic at hand, that is, the manager ensures that messages within a given discussion do not stray too far from the main theme. If necessary, the manager has the authority to move messages to a new topic or delete them altogether.

Newsgroups

Although newsgroups and discussion centers perform similar functions (e.g., sharing information), they actually differ in their distribution to readers. While most Discussion Centers are restricted to *Learning Link* subscribers only, newsgroups may be disseminated statewide, nationwide, or even worldwide.

Most of the newsgroups on Learning Link nodes are a special subset of "netnews," which contains more than 1500 publicly-distributed newsgroups covering a wide variety of topics. Many of those newsgroups are not relevant to K-12 educators, so PBS ONLINE has either adapted existing ones or created new ones expressly for *Learning Link* subscribers.

Acquiring a *Learning Link* Account

Local PBS affiliates manage new *Learning Link* user accounts, and they will provide the details for the general application process. Further information can be obtained from:

PBS Learning Link
1320 Braddock Place
Alexandria, VA 22314-1698
703-739-8464

Summary

Learning Link offers a wide variety of resources that educators can use to enhance instruction in the classroom including e-mail, discussion groups, forums, interactive databases, and newsgroups. The purpose of this document was not only to illustrate (in general terms) the resources and capabilities *Learning Link* provides to educators nationwide, but also to encourage teachers to explore the wealth of information that *Learning Link* places at their fingertips. For the true power of *Learning Link* emerges when educators go beyond reading about these resources and begin to apply them as part of their day-to-day instructional strategies.

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TECHNOLOGY DIFFUSION

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We are beginning to appreciate more of the total picture [of educational change]. What appears simple is not so—introducing a seemingly small change turns out to have wild consequences. What appears complex is less so—enabling a few people to work on a problem produces unanticipated windfalls.

-Michael Fullan (1993, p. viii) from *Change Forces*

Educational change with technology is complex and difficult. In his new book, *The Children's Machine*, Seymour Papert (1993) discusses the "megachange" that has occurred in many areas of human activity—telecommunications, entertainment, transportation, and medicine. He cites schools, however, as a notable example of an area that has not been significantly impacted by advances in technology. "The development of a megachanged learning environment," Papert contends, may have to "grow slowly in an organic way (p. 216)." Perhaps the best that reformers can hope for is what Larry Cuban (1993) characterizes as a "cautious optimist's scenario" in which "putting computers in classrooms will yield a steady, but very slow movement toward fundamental changes in teaching and schooling (p. 195)." One thing, though, is certain. Educational change with technology is indeed moving forward.

This section documents a wide variety of issues and initiatives related to the diffusion of technology in teacher education programs and K-12 schools. It begins with a paper by Johnson, Maddux and Harlow that presents an exciting vision of technology-based innovations that they believe will impact schools in the coming years. Though the authors admit that the "marriage between education and technology will not happen as quickly as we would like," they conclude that it will indeed happen and challenge teacher educators "to roll up their sleeves and be part of it." In contrast, Bennett and Bennett examine many of the difficulties of technology diffusion in K-12 schools. The authors write of a study conducted with teachers in rural America that documents budgetary constraints and the prevailing notion among many teachers that computer integration primarily involves drill and practice to support traditional classroom instruction.

The following group of papers focuses on efforts to integrate technology into various facets of the teacher education program at Marywood College. This cluster of papers reflects the growing collaboration that is alluded to throughout many of the articles in this section. Burkhouse describes attempts to systematically integrate technology in their program and details specific applications and assessment procedures used. Draina documents inservice opportunities that incorporate technology in science and math methods as well as strategies used to provide leadership candidates with skills needed to support infusion of technology. Ruthkowski then describes efforts to produce interactive video programs on topics of concern for preservice teachers. Finally, Sadowski, the College's Director of Academic Computing, writes about proactive, reactive, and collaborative approaches to supporting faculty in their work with technology.

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Other attempts to integrate technology into teacher education programs are presented in the next group of papers. Beacham describes an approach where methods faculty, classroom teachers, corporate representatives, and undergraduate students collaboratively designed and implemented initial phases of a technology infusion plan. Fox and Thompson document another university's approach which includes one core course in technology followed by technology-based learning activities in other education courses. Next, Smith describes the collaborative effort to infuse technology into the course work and field experiences of elementary certification students who are being prepared to serve as catalysts for classroom change.

The explicit themes of educational change and change agentry in K-12 and university settings are addressed in the next cluster of papers. Bennett presents the case that school principals must know how technology can be used to support instruction and administration, and then assist their faculty in creating and realizing a technology-enriched vision for their school. Strudler describes the work of other change agents—school-based technology coordinators. In his follow-up study, he documents many impediments to meaningful technology integration in elementary schools and discusses the implications of these findings for teacher educators. Kline, then explores issues pertaining to change process that must be addressed to support the increased use of multimedia in teacher education. Munson, Poage, Conners and Evavold further document the change process as they describe psychological and sociological factors involved in their collaborative faculty development project in which they designed computer-based courseware for graduate sections of their Research and Statistics course. Following, Van Tassell and Yeager discuss their conception of the connective skills that teachers and students must develop to thrive in the information age.

The next group of articles focus on issues pertaining to staff development. Gunn details a model for faculty development in her teacher education program that includes technology infusion, support, and faculty release time. Schmidt, Merkley, Strong and Thompson describe the mentoring approach that was used to assist education faculty in using technology in their courses during the second year of their technology integration plan. Significantly, this paper focuses on the interpersonal contact required and the commitment of the university administration to provide release time for professional development activities. Next, Grejda and Smith write about the goals, objectives, and implementation of a staff development program for education faculty and faculty in neighboring schools. Barnes and Ziegler then describe a staff development model for the transition from DOS to Windows piloted in the Curry School. Finally, Honey et al. describe an exciting online learning forum in which K-8 teachers are engaged in on-going conversations about innovations in content, teaching, and assessing learning in mathematics.

The last group of papers focus on the work of three collaborative, university-school district partnerships involving technology and education. Hoskisson, Pullen and Thompson document the establishment of the State Center for Innovation in Instructional Technology, an innovative program for teacher preparation. Baile then outlines issues involved in the Curry School's efforts to establish an educational technology consortium which would promote the development of shared instructional technology classrooms and an annual conference. Finally, two papers describe work in the Professional Development and Technology Schools Project in Houston, Texas. The project was created to prepare teachers who are capable of effectively integrating technology with culturally diverse student populations. The first paper, by Robin and colleagues, provides an overview of the work to create technology-rich professional development schools. The second paper, by Willis, Price, and Robin, describes one of the products being developed for use in the project—a CD-ROM with material of interest to teacher educators.

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Technology and Education: A Successful Marriage for the Twenty-First Century

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To set the stage for what we want to say in this paper, we refer to Seymour Papert's latest book *The Children's Machine* (1993). In this book, Papert takes the position that "megachange" has occurred in nearly every field of human endeavor with one notable exception—education. Papert's major premise is that megachange will also come to education as we move into the next century. He believes, as do we, that technology will play a key role in bringing about and shaping this megachange. This places an enormous responsibility on those of us who are involved in technology and teacher education. We must have a vision of this marriage and that vision must be based on sound theory, logic, and practice.

While education and technology have only flirted with each other in the past, we believe a true marriage will take place in the future. This can be a successful marriage. It can provide technology enthusiasts opportunities to realize some of their long-held dreams. Bringing technology into education will bring more than just new ways of managing and conducting education, it will bring new ways of thinking about education. Papert (1993) describes how using early computers changed the artillery specialists craft with the following statement: "Although the ultimate goal was the same, the means were more than just quantitatively different; they were epistemologically different in that they used a different way of thinking" (p. 185). We are positive about the future of technology in education because we believe that it can help bring about epistemological changes in the way we think about teaching and learning.

In this paper, we will present some of the positive vision we have for the schools after the marriage of technology and education has taken place. A few facets of our vision will be discussed along with their technological considerations. These facets constitute some of the areas we believe teacher educators need to be exploring, developing, and promoting.

Computer as Teacher

One of our first tasks will be to lay to rest the pervasive tendency to contrast the teaching effectiveness of a teacher with the effectiveness of a computer. An example of this tendency can be seen in a quote by Lewis Perelman, who in a Wall Street Journal article said: "I recently witnessed a demonstration of a computer program that can teach any student of any age to read English up to any level of proficiency" (cited in Cannings & Finkel, 1993, p. 5). In addition to being a gross exaggeration, such a statement suggests there is legitimate competition between computers as teachers, and human beings as teachers. We suggest that this is a fatuous competition. More importantly such statements suggest to people who control money, and who do not know better, that purchasing computers can bring about more cost effective education than hiring teachers.

Part of our vision, is that computers will be thought of as teaching tools. We would like to see them thought of as tools that are used in dynamic teaching and learning environments; tools that teachers and learners will use together, and tools that will help good teachers become better teachers.

Megachange

Papert's (1993) idea of megachange involves a rethinking of fundamental ideas about what it means to teach and to learn. Cleborne Maddux (Maddux, Johnson, & Willis, 1992) has spoken widely of Type I and Type II software. Type I software can be characterized as using technology to do what we have always done, but in a slightly different way. Type II software can be characterized as using technology to do things that have never been done, or that were thought to be impossible. What we as teacher educators need to become involved in is bringing about Type II change in education. We can do this by preparing teachers to understand the potential of technology to help us do what has never been done, and what was previously thought impossible. Using technology to automate or just enhance what we have been doing for the past 100 years will bring little meaningful change to education and surely not megachange.

Some of the ingredients we would like to see in this megachange, when technology and educational are truly wed, follow.

Active Learning

It has been over a hundred years since John Dewey proposed the radical notion that the best learning environment is one where learners are active and self-directed. We believe that technology has the potential to make such learning environments possible and practical. In fact, as technology becomes more pervasive, learners will demand such learning environments.

Critical Thinking

Among the greatest problems in our system of education is the emphasis on coverage for the sake of coverage. Much of the literature on critical thinking addresses this problem. Richard Paul (1993), a leader in the critical thinking movement says that:

> One of the major problems of many didactic-oriented courses is that students develop the illusion of understanding many things that they, in fact, don't really understand at all (p. 11).

We believe that technology has the potential to allow students to explore concepts and ideas to a point of deep and thorough understanding. They will not do this, however, as long as we perpetuate the idea that there are a set number of curricular items that must be covered in a given course *regardless of level of mastery*. Teacher educators, however, must be careful not to use the criticism of coverage as an excuse for inadequate coverage. Our goal should be to promote *in-depth understanding of the essential elements* of a given topic.

Teaching is Not Just Telling

One of the authors of this paper, LaMont Johnson, likes to tell the story of a time he was required to participate in a peer evaluation process. A team of colleagues were scheduled to appear in his classroom to observe and evaluate his teaching. He had gone to great effort to organize a class session that involved students in a simulated exercise directly related to an important part of the course. The simulation went well. At the end of the class one colleague said "That was good, but I have been in your class on several occasions now, and I have still not seen you teach."

There is a popular myth, both in and out of school, that defines teaching as standing in front of a group and talking. We think teaching occurs when teachers and students engage in various learning activities, in various ways, with the teacher orchestrating the total event. Technology can provide us with the tools for conducting learning symphonies far richer and more exciting than anything we have even dreamed of in the past.

Next, we will turn our attention to some of the ways we think specific technological applications will play a role in bringing about megachange:

Interactive Multimedia

Interactive multimedia will help us discover different ways of thinking about learning. John Hirschbuhl (1992) provides a concise description of what this means:

> Today we are using multimedia as a tool for helping learners master thinking skills for assimilating massive quantities of information. In order to make full use of technology, multimedia must be used as an engine to enable learners to transform information into knowledge by means of inquiry based on higher-order thinking (p. 321).

The vision the interactive multimedia enthusiasts have of learners navigating their way through vast databases of text, sound, graphics, and video is exciting. While there is plenty of room for skepticism, and while it is easy to point to the need to move slowly, this whole movement definitely suggests that technology may well provide us with the tools that can help us gain new insights into learning processes. Such insights may then translate into increased learning efficiency.

Telecommunications

Computer telecommunications can help us discover different ways of thinking about how to organize a classroom. It is clear from recently proposed actions on the part of government that a National Information Infrastructure will be expanded and refined to serve the entire country. It is also clear that services to schools will make up an important element of this huge network. As this happens, we will see classrooms with one or two computers connected to a universe of information resources. Instead of students thinking of their basal texts and a meager library as informational resource, they will think about the libraries of the world, scholars at major universities, government agencies, other teachers, and other students as sources of information. To incorporate this vast informational resource into the teaching and learning process, creative ways of organizing the classroom for learning will develop.

Such creative classrooms will require movement. If we were to visit such a classroom, we might find students moving from the information stations, to discussion groups, to other work areas, to the teacher station, and back to an information station.

Logo Genre Software

Logo genre software will help us discover new ways of thinking about what it means to teach. We use the term "Logo genre software" to suggest the type of software that intends to create a whole learning environment, similar to the Logo microworld concept. Harper (1989) defines the Logo microworld as a place "where the user is given personal control over the creation and discovery process" (p. 27). Teachers who use technology in this way will find themselves relinquishing control and working more as facilitators. In a true discovery learning environment, students and teachers will often be discovering together.

Virtual Reality

Virtual reality will extend the classroom far beyond what we have imagined. Papert (1993) tells a story about working with a young student who wanted to know how giraffes sleep. Papert got interested and went to his personal library to find the answer. He expresses the idea that by searching through his books, with their words and pictures, he experienced an *extended immediacy* (p. 8.) to Africa and the giraffes. Hirshbuhl (1993) defines virtual reality as "a technology that demonstrates that we are on the brink of having the power to create any experience that we desire" (p. 166).

Think of the "extended immediacy" virtual reality will one day provide. For those who are skeptical, witness the motion video theaters that are springing up at various amusement centers. In these theaters, people take simulated dangerous journeys, where they experience many of the same sensations as those experienced in the real trip. The question of how close a student can come to visiting Africa, without visiting Africa, is impossible to answer right now. One thing is sure, however, Africa will be brought a lot closer to the American classroom of the future than it is today.

Conclusion

The marriage between education and technology will not happen as quickly as we would like. But it will happen. In the end, it will be a positive relationship and American society will be better because of an improved educational system. We can either be part of the wedding party, or we can watch from the street. Our challenge to teacher educators who have a vision for the megachange that will occur when the marriage takes place, is to roll up their sleeves and be part of it. The place to start is in our own classrooms.

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United We Stand: A Portrait of Teachers and Technology in Rural America

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Society is riding a technological tidal wave unprecedented in human history. Developments in computers and related information technologies forge fundamental changes in the ways we communicate, yet the American educational system makes little progress incorporating new technologies into classrooms. Although computers can be found in almost every public school in the United States, research has shown the integration of computer-assisted instruction into the curriculum to be minimal (O.T.A. 1988; Preston, 1990; Waxman & Huang, 1993). Teachers engaged in the technology race are finding it difficult to succeed due to lack of resources, support, and technological training (Jongejan, 1990; Knupfer, 1989; O.T.A., 1988).

There seems to be a philosophical consensus within the educational community that teachers and students should be technologically proficient, but there is little resolve "to put our money where our mouth is." School boards mandate the use of computers without understanding the complexities of issues involved in computer-assisted instruction, systems and software are purchased without consideration of the impact on instructional delivery, and the installation of sophisticated computer systems in classrooms is equated with doing what we can to assist teachers in preparing students for the future. So where do teachers and technology stand in 1993?

For more than a decade, the authors of this paper have observed teachers' reactions to the introduction of computers into the classroom. As with any innovation, we've seen teachers respond to the arrival of a computer into their classroom in one of two ways: they either pretend it isn't there or they learn to use it. Some teachers find no joy in the arrival of a new computer in their classroom. They are overwhelmed with the prospect of not only having to learn to use the machine themselves as well as learning how to integrate the use of it into their instructional repertoire. As a result, the uninvited stranger is ignored. Typical coping strategies used by teachers in this situation include leaving the computer unplugged and covered up in a corner of the room, telling students it is broken, or letting students use it as an arcade-type amusement.

Not all teachers, however, have poor attitudes and skills about using computers in their classrooms. It appears that a relatively small, but growing number of teachers welcome new computers into their classrooms and use them as an integral part of instruction. They explore new software and technologies and willingly try new instructional strategies.

As the Director of a Master of Arts in Education program in rural southeastern Ohio and an educational technology consultant, these authors became especially interested in what factors influenced teacher attitudes toward computers and how the machines were being used in classrooms. It was the Director's responsibility to revise the graduate teacher education curriculum to include instructional technology components, and the consultant's role to investigate the status of technology use by area schools. By interviewing teachers, school administrators, college instructors, and undergraduate and graduate students, we developed the following hypotheses:

(a) teachers want desperately for their students to succeed and receive the best possible education,
(b) teachers realize the growing need for students to be able to manage information in our society,
(c) teachers who use computers have a different attitude toward the use of technology in education than teachers who don't, and
(d) teachers feel unsupported in their attempts to wrestle with the integration of electronic media into chalkboard pedagogy.

This paper reports the findings of a research study which provides a portrait of teachers and technology in rural America.

The Study

In July 1993, the authors conducted a study designed to formally examine the attitudes of practicing teachers toward technology in education and determine the level and type of computer usage in their classrooms. A sample of fifty-seven teachers enrolled in a Master of Arts in Education program were surveyed. Participants taught grades ranging from K-12 and represented fifteen rural school districts in southeastern Ohio. The average age of participants, which included 13 males and 44 females was 37. Years of teaching experience ranged from 2 to 27, with an average of 11 years.

Methods

Participants completed a three-part survey, the first two of which included a demographic section and a set of open-ended questions designed to determine amount and type of their classroom computer usage, to examine their perceptions of the value of instructional technology, and to investigate their perceptions of the level of school district and administrative support. In the third section, participants used a nine-point Likert-type scale to indicate strength of agreement with statements regarding attitudes toward both personal and professional uses of computers. Follow-up interviews were conducted with a subset of 10 participants.

Data analysis of the qualitative portion of the survey began with categorizing and coding open-ended responses to questions. Categories were identified and the frequency of each response was determined and described. Results of the Likert-scale portion of the study were analyzed statistically using paired t-tests and standard deviation to determine if any statistically significant agreement was reached and if any statistically significant differences existed between identifiable groups.

Results

Of the 57 teachers surveyed, 38 (67%) reported regular personal use of computers, mostly for word processing. Twenty-two of the 38 teachers (58%) who used computers on a regular basis and had a computer in their classroom reported having integrated computers into their instructional practices.

Nineteen of the 57 participants (33%) did not make personal use of computers on regular basis. Four of these teachers had a computer in their classroom, and two of these four reported having integrated computers into their curriculum.

The 26 teachers with computers in their classrooms reported student usage ranging from robotics to games. The majority (23) of teachers identified drill and practice, word processing, and games as the most common uses of machines by students. Seven teachers indicated that the average amount of time their students spent with computers per day was less than 10 minutes, seven said their students spent 10 - 15 minutes per day at the computer, seven said their students had 20-25 minutes per day, and five teachers (three of whom were responsible for computer labs)

Table 1
All teachers responses to Likert-scale questions (n=57)

	Mean	SD
Computer use part of all aspects of education	7.1	1.9
District has helped me substantially	3.4	2.2
Students are technologically ready	4.1	1.8
Computers are useful in my teaching	5.8	2.4
Computers are useful in my personal life	6.7	2.3
Administrator strong proponent of computers	5.9	2.3
Subject of computers and technology is irritating	2.3	2.0
Too busy to incorporate computers	3.3	2.6

Table 2
Teachers who regularly use computers compared to those who don't use computers on a regular basis

	(n=41) Do use		(n=16) Don't use		*t*-test	
	Mean	SD	Mean	SD	*t*-value	*p*=
Computers part of all aspects of education	7.1	2.0	7.0	1.7	-.177	.8615
District has helped me substantially	3.5	2.3	3.1	2.0	.589	.5651
Students are technologically ready	4.1	1.7	4.2	1.9	.905	.3817
Computers are useful in my teaching	6.5	2.1	4.3	2.4	**4.516**	**.0004**
Computers are useful in my personal life	7.7	1.4	4.3	2.1	**6.016**	**.0001**
Administrator strong proponent of computers	5.9	2.2	5.7	2.6	.5202	.659
Subject of computers is irritating	1.8	1.5	3.4	2.5	**-2.971**	**.0101**
Too busy to incorporate computers	2.6	2.0	4.6	3.2	**-2.147**	**.0475**

Table 3
Teachers who had integrated computers into their instruction compared to those who had not

	(n=22) Do use		(n=35) Don't use		*t*-test	
	Mean	SD	Mean	SD	*t*-value	*p*=
Computers part of all aspects of education	7.8	1.2	6.6	2.1	**2.386**	**.0270**
District has helped me substantially	4.1	2.4	2.9	1.9	**2.5**	**.0226**
Students are technologically ready	4.6	1.6	3.9	1.9	1.32	.2042
Computers are useful in my teaching	6.8	1.9	5.1	2.5	**2.414**	**.0261**
Computers are useful in my personal life	7.3	1.9	6.2	2.4	.348	.7319
Administrator strong proponent of computers	6.0	2.2	5.7	2.5	.692	.497
Subject of computers is irritating	1.9	1.8	2.6	2.1	-.889	.3855
Too busy to incorporate computers	2.1	2.0	4.1	2.6	**-2.147**	**.0449**

responded that their students used computers 40-45 minutes each day.

Responses to the Likert-scale questions were analyzed statistically. Table 1 shows the standard deviations and means obtained by grouping all teachers together. Neutral responses hold a value of 5, responses greater than 5 show agreement, and responses less than 5 indicate disagreement. Teachers agreed that computers should become part of all aspects of education. Teachers did not feel that their district helped them significantly to integrate computer use into their curriculum. They also did not believe that their students were technologically ready for employment or higher education after graduation from high school. Teachers perceived computers to be useful personally and in their teaching and school administrators were generally seen as proponents of computer use. They reported that computers should be integrated into the system and indicated that integration of computers into classroom instruction must begin immediately, regardless of workload or district support.

Data were then analyzed by grouping teacher responses based upon whether they did or did not use computers on a regular basis. Table 2 shows means, standard deviations, and paired *t*-test results for each group. Significant differences were found between computer users and non-users on several questions. Teachers who did not use computers on a regular basis viewed computers as less useful, both personally and professionally, and more irritating than regular computer users. Non-users were also more likely to view themselves as "too busy" to incorporate computers into their classroom instruction.

Finally, data were grouped by whether the teachers had or had not integrated computer-assisted instruction into their curriculum. Table 3 shows means, standard deviations, and paired *t*-test results for each group. Statistically significant differences were found between responses on four questions. Teachers who have integrated computers into their classroom instruction were more likely to agree that computers should be a part of all aspects of education, that their districts had been helpful, that they found computers to be useful in their teaching, and they were not too busy to incorporate them into classroom practices.

Though most (56%) of the 57 teachers responded that their school district and administrator supported their use of computers in the classroom, they also indicated that a lack of school funding limited the support that was given. Teachers described several kinds of support they had received, including new hardware and software, a pat on the back for trying to use a computer in the classroom, inservice training, help from a district specialist, and a policy allowing teachers to take computers home.

The study also found that the majority of participants (87%) strongly agreed that computer use should become part of all aspects of education, but felt school districts and the public did not adequately fund technology in education. Most teachers thought districts should provide more money to purchase hardware and software, to maintain equipment in current use, and to provide inservice training.

Finally, when teachers were asked to describe their thoughts on the place of computers in the educational system, all 57 agreed that computers should be an integral part of every classroom. However, they expressed concern about when and how that would happen given the lack of funding for equipment and inservice training. Teachers were deeply concerned about their inability to prepare students with the technological skills they need now and in the future. Ninety percent of all teachers believed high school students were not technologically prepared for the job market at graduation.

Conclusions and Implications

This study focused on a relatively small group of teachers from rural school districts. Their attitudes toward and usage of technology in their classrooms parallels the results of similar research with other populations. Personal users of computers who had computers in their classrooms were the individuals who used computers the most in their teaching.

It appears that the more teachers know about technology, the more articulate they become in describing their needs and the more likely they are to use technology in their classrooms. Individuals participating in this study who did not have access to a computer for personal or classroom use only indicated that they needed equipment and software. Teachers who did have computers available indicated needs not only for additional hardware and software, but also for inservice training and the maintenance and upgrading of equipment.

In many teachers' minds, the solution to the problem of advancing our schools technologically seems simple, or at least there are simple first steps they think can be taken - give them a machine, give them software, and show them how to use it. But all too often, the machine and software never arrive or are received unusable.

Experience tells us that even when the needed equipment and materials do arrive the rest of the process is not so simple. The purchase of equipment is only the beginning of a long, expensive, complicated process. Long-range planning; teacher training; follow-up support; purchase, review, and upgrade of software; and maintenance and upgrade of equipment require dollars not available to or inadequately budgeted for by school administrators.

It was interesting to find that most teachers who reported having integrated computers into their curriculum and instruction interpreted that to mean computers were used to support traditional classroom instruction by means of drill and practice or computer games. No teacher talked about using databases, desktop publishing, or telecommunications to enhance instruction. Very few mentioned other technological devices that, when used with computers, can greatly enhance the quality of instruction. This indicates that these teachers, like many others, view the use of computers as a supplementary means to reinforce existing practice. The larger picture of integrating computer-based writing, problem solving, and other higher order cognitive skills into all the curriculum was nonexistent in this case.

All teachers in this study stood united on one issue - their view on technology's place in education. Though they had a narrow view of what such integration might be, they all agreed that computers and other information technologies must be fully incorporated into the educational system.

Teachers at all grade levels also agreed that today's high school graduates are not technologically prepared for either the workplace or higher education. If our society is going to survive economically in today's and tomorrow's markets, then we must prepare students to succeed in a technological environment.

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Aligning Information Technology With Curricular Intent

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As teacher educators, most of us have probably found ourselves admonishing prospective teachers to clarify instructional purpose or objectives before designing activities, since the latter, without grounding in the former, are unlikely to be purposeful. Similarly, it is appropriate for us to apply this principle in making decisions regarding the use of technology, especially when it is increasingly abundant, dramatic, and costly. Unless we do so, we risk proliferating technological "add ons" in courses and programs which are already "full." In this paper I will recount the recent efforts of colleagues at Marywood College to systematically integrate technology throughout teacher education curriculum.

Undergraduate faculty at Marywood College worked on teacher education curriculum revision, supported by Title III funding in the years 1990-1993. In line with accreditation standards of the National Council for the Accreditation of Teacher Education (NCATE, 1990) and also Galluzzo & Pankrantz (1990), we first collaborated across departments and with elementary and secondary teachers to articulate the knowledge base undergirding our teaching efforts and program design. Formally, we committed ourselves to principles and practices such as active learning, respect for cultural differences, and reflectivity. In particular, we pledged to model technologically rich learning environments in our own work and to promote our prospective teachers' effectiveness in such settings.

Technology Supporting Instructional Purpose

In curriculum revision workshops with school practitioners, we conceptualized instructional technology as a support rather than a separate goal. But, meanwhile, we had in place a required, separate, media course for elementary teachers, while a much less substantial skills test component in a generic curriculum and instruction course sufficed for secondary and K-12 students. Obviously, in this design, faculty could only promote, rather than assure, media integration and application. Eventually, following sometimes painful and usually spirited deliberations, we eliminated the separate course and agreed that while every teacher education faculty member would assume general responsibility for modeling effective use of instructional technology, it was necessary to assign individual accountability to assure student use and skills development with specific technological applications.

Following is a description of several applications for which I have responsibility, including the instructional purpose, the requirement for student use, and successes or difficulties associated with implementation.

Video Cameras/Camcorders. Many significant aspects of teacher behavior can only be captured visually. Neophytes often do not realize that they fail to maintain eye contact, for example, or that their facial expressions convey more than their spoken language. As camcorders become less expensive and more simple to operate, they offer opportunity for reflection and analysis.

Elementary education students teach their peers to use specific instructional resources for mathematics; in another semester, they report on a current educational issue, such as home schooling, for a foundations class. Both tasks are intended to blend content mastery and communications skills; prospective teachers receive written peer commentaries and an instructor evaluation. Finally, they write a self-analysis, after viewing a tape recorded by a peer.

We enjoy the luxury of camera delivery and set up prior to class time, and to date, the class always includes some experienced users. We encourage students to operate the cameras, which models the advantage of peers sharing expertise.

After class, the tape, with presenters' names listed on its slip-case, is placed in our curriculum laboratory, allowing for private viewing outside of class time. While we supply a general tape for class use, I encourage individuals to bring their own tape for portfolio purposes. Occasionally the schedule is foiled by unexpected absence of the recorder (each student must discharge this responsibility) or presenter, and novices have, on rare occasions, inadvertently rewound and recorded over earlier presentations. Otherwise, student filming skill has been adequate, peer satisfaction is high, and the self-analyses indicate sensitivity to essential and subtle teaching behaviors.

Word Processing Software. Given the increasing use of word processing by young students, the demands for writing across the curriculum, and the expectations for professional productivity, it is not surprising that we promote the use of this utility. Both of the courses cited earlier require production of materials by word processing. In a methods class, students must use a template to prepare plans for their tutorial; they receive strong encouragement to employ word processing in other assignments such as teaching logs. In the foundations class, they must submit their research paper formatted in APA style and produced via word processing.

The activities described are not the initial word processing experience for students, so the actual document production is not a major challenge in most cases. Furthermore, to reduce anxiety of the occasional novice user, word processing (as well as camcorder) experience is one of the factors I consider in making heterogeneous cooperative group assignments. Each work group of four or five has at least one or two skilled users, who, along with the Academic Computing Center staff, serve as consultants for the task.

The real challenge for most individuals lies in the APA formatting. While we recently acquired a software package which should facilitate this task, I confess that its mastery is still on my own "to do" list!

Spreadsheet Software. Our decision to incorporate spreadsheet technology was more selective than the other media forms cited earlier because its need is less universal across curricular areas. Unnecessary to effective teaching in children's literature, the ability to do "what if?" data management is significant in other fields. For example, one colleague has prospective teachers compute averages as part of an elementary seminar and another does equipment budgeting in a management course for early childhood educators. My own utilization is in mathematics pedagogy, in the "How many of each coin would you have if the total of your fifteen coins is $2.87?" genre. Each of the faculty cited uses a pre-developed template, so students' effort is spent in working with the data rather than in determining the formulas which structure the table.

My experience here is quite limited, but to date I find that this application requires relatively more instructor support, since student prior use is limited. At present I perceive students as using this software to fulfill assigned tasks; most do not yet generalize its power for their own initiative. Nevertheless, they appreciate the opportunity to focus on the conceptual rather than the computational aspect of the question under consideration.

Commercial Instructional Software. Traditionally we have required our students to support their own instructional planning, by choosing appropriate trade books or educational films. But many completed their own elementary and, in some cases, even their secondary education without extensive benefit of computers. Few have had personal experience with the broad array of commercial software increasingly found in schools. We acknowledge that our mission is not to prepare computer specialists who will oversee self-contained labs, but classroom teachers who should know the needs of their students and the potential of their curriculum. Consequently, we require that they work through representative software and evaluate the programs on the basis of their being developmentally appropriate, instructionally relevant, and easy to operate.

This is a favorite task, perhaps because school software is often attractive and sometimes its content does not challenge new college-level users. Ironically, though, prospective teachers have been known to report on the "impossibility" of a piece of software, only to be informed by a parent or teacher that it is a great hit with youngsters! Simultaneous field experience offers a "reality check" on such assertions, much as it raises expectations of children's computer facility. Overall, the chief advantage of the software review task seems to be the increasing ability of future teachers to identify valuable computer software resources for their own teaching, whereas previously their resources were limited to print materials.

Electronic Data Bases. The rationale for requiring facility in automated information retrieval is obvious; teachers must acquire data, and it is no longer adequate to limit one's research skills to card catalogs and written indices. Still, our work in this resource is comparatively unsophisticated. For example, effectively utilizing Internet is still in the future tense; for the present our students must demonstrate ability to search library holdings electronically in order to identify resources for research papers and presentations. Since we began requiring submission of print-outs from searches we are witnessing a consistently improving level of professionalism in references.

The problems associated with this curricular component are minor. Introduction of the resource in earlier coursework demystifies the requirement in the capstone foundations course. Excellent reference staff in the Learning Resources Center are patient with those who lack confidence or skill in searching. An occasional user forgets how to stop printing an indiscriminately long list of resources, but the only other student complaint is that the College does not hold every possible source for a paper being researched! Actually, this testimony has raised our own ability to make more significant purchasing recommendations.

Overhead Projectors. As we consider our rationale for requiring prospective teachers to use the relatively simple, and surely ubiquitous, overhead projector, some of us confess that it is because we've all seen them so poorly used so often! Since overheads can be used by youngsters, since they naturally provide spontaneous joining of the audio and visual modalities, and, especially because they permit eye contact with viewers (a major factor in classroom management), we believe that they are essential. However, whereas many students have had at least limited experience using most of the other media forms cited above, virtually none has had reason or opportunity to learn effective use of overhead projectors outside the teacher education sequence.

We find the need to provide preliminary information regarding transparency design and to encourage actual rehearsal of the projector's use, so prospective teachers learn how to focus a specific transparency on a given machine in a specific setting—and then to stand without blocking its triumphant image!

Actual implementation of this technology has been uneventful. Teacher candidates make the predictable mistakes of crowding the transparencies, of facing the projector in the wrong direction, and of lettering with an attractive-but hardly legible-pastel marker. They recover quickly, however, and are eager to add the overhead to their repertoire of "real classroom" skills.

Final Word

Although it is too early in the curriculum revision implementation to share firm assessment indicators, I endorse the logic of integrating technology and requiring evidence of skillful use throughout the teacher education sequence. Presentations by my colleagues, Professors Ruthkosky, Sadowski, and Draina, detail other applications.

Credits and Acknowledgments

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Technology in Schools: A Call for Curriculum Integration

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A critical element in successful educational reform is well-planned, site-based infusion of technology into both elementary and secondary classrooms. Educators continue to discuss the merits of technologically rich classrooms and the place instructional technology should play in the teaching-learning process. The current challenge is movement from discussion to action. Some teachers are using technology, mainly computers, to remediate and motivate. A few teachers move beyond this level to more sophisticated applications. So much more is needed.

This paper addresses the need for K-12 administrators and teachers to approach the infusion of technology into schools and classrooms in a holistic fashion. It is an attempt to heighten awareness of the need for a deeper understanding of the place technology must play in curriculum renewal. It is a call for inservice training in technology that is site-specific and embraces a vision both the administrator and teachers hold for the best learning possible for all students.

As a case in point, the paper will describe the manner in which Marywood College graduate school faculty utilize funding initiatives in science and mathematics to develop inservice opportunities which integrate science and mathematics content with technological applications. Strategies used to provide leadership candidates with skills needed to support infusion of technology in schools also will be discussed.

Where are we now?

The use of technology in the classroom is making a difference. Betty Collis (1990) reviewed over 180 studies of student achievement and attitudes toward learning. Her conclusions indicate that computers are remarkable catalysts for educational excitement, self-examination, and intellectual growth.

Sheingold and Hadley (1990) report three major changes taking place in technologically enriched classrooms:

1. Teachers present more complex material and higher expectations of their students.
2. Teachers can better meet the needs of individual students.
3. Integrating the computer turns a teacher-centered classroom into a student-centered one, with more collaboration among students and between student and teacher, and with the teacher acting more as a coach than as a dispenser of information.

Most professionals involved in educational reform and restructuring agree that technology allows both the teacher and the student an opportunity to experience new ways of learning. Instructional technology supports, enriches, and facilitates good teacher planning and instruction. The computer can transform the classroom from a passive, one-directional, adult-centered learning space into a thinking, organizing, revising, active area where each child is engaged in problem solving and collaborative learning.

Unfortunately, however, many studies find little computer/curriculum integration (Becker, 1989; OTA, 1988). Sheingold and Hadley (1990) report that computers are not being used systematically as tools across the curriculum and that, although computer use has changed somewhat within the past decade, it remains the case that computers are not an integral part of subject matter instruction. Surveying 600 computer-using teachers, they found that most take at least five years to "master" computer-based instructional practices.

Where do we go?

Educators seriously engaged in revitalizing their curriculum begin the process by asking some key questions, such as: "What do we know about how children learn?" "How is our current program either meeting or not meeting the needs of our students?" and "Why do we want to change a program?"

Carefully facilitated discussions between leaders and teaching faculties can build a solid foundation upon which curriculum improvement can be made. Ideally, a school or school district will analyze where it has been and where it wants to go to establish a broad-based curriculum framework complete with goals, objectives, strands, and skills. Only then does further refinement produce courses of study and unit plans into which technology is integrated.

A simple, systematic plan for technology infusion into curriculum revision is imperative. Planning for technological integration requires seeing the whole picture and dealing with total application. Dimensions include instructional and administrative technology applications, consideration of learning and teaching styles, facilities to support technology use, and, finally, decisions regarding appropriate hardware and software purchases.

Higher Education's Role in Inservice Training

Well-designed and thorough staff development can make technology infusion a reality. One vehicle for such inservice education is collaboration between institutions of higher education and local districts. Colleges and university typically have the resources to provide the follow-up support needed to create the foundation for long-lasting change.

This type of collaboration has proven valuable at Pennsylvania's Marywood College, where in 1990 and 1992 K-6 teachers participated in a graduate-level course entitled "Cooperative Learning with Mathematics and Microcomputers." Practitioners designed math lessons and units of instruction which embodied the principles of cooperative learning, National Council of Teachers of Mathematics (NCTM) standards, mathematics manipulatives and microcomputers. Student responses at the conclusion of the course indicated that they not only consumed knowledge, but also produced knowledge and felt responsible for their own learning. Most importantly, they felt that this experience would "make a difference" in their classrooms. Technology did not drive the program, but it was an essential ingredient in the positive student outcomes.

Similarly, through Eisenhower funding, the college has offered "Strategies for Effective Science Teaching," a course designed for K-6 science teachers. The course outline was but a framework which allowed the application of a variety of teaching-learning strategies such as thematic instruction, cooperative learning, hands-on science, and the use of technology. As interdisciplinary themes were developed, the integration of a variety of technologies including microcomputers, laserdiscs, and videotapes was stressed.

It is clear that in both inservice training experiences the classroom teachers needed to be motivated to integrate technology in their programs. At first, due to their lack of knowledge and training, they were apprehensive and skeptical; but using simple approaches that are easily transported to K-12 classrooms won the majority of the teachers over.

Teachers can take the lead when it comes to a broader understanding of curriculum renewal and how technology fits into this reform. Teachers know how to carefully integrate new technologies into skeptical, cautious, and traditionally structured environments. Teachers are key to the infusion of technology into the curriculum.

Administrative Support

The ecology of schools provides us with the reality that the school or school district's vision is centered in the persons holding positions of leadership. Research tells us that the principal is the key figure in effective schooling. It follows, therefore, that the impetus, the spark, for the infusion of technology into curricular reform would be with the building administrator.

School leaders can support a technological evolution by expanding their vision of quality schooling to include technology-rich classrooms. This vision must then be accepted by all stakeholders in the educational community and focused in creative, site-based planning procedures which realize that electronic learning is not the future, but now. Administrators must give teachers the tools, staff development opportunities, and time to experiment with and learn to teach with technology.

In Marywood College's School Leadership training program, future school administrators are immersed in strategies to effect school change. Change is addressed through a study of successful leadership strategies including curriculum design, budgeting, and fund-raising initiatives that have the potential to move away from "business as usual." High on the list of all these strategies is the application of technology and the impact it must have in connecting all that leaders do to effect change. Students are given opportunities to meet and converse with Instructional Technology majors. These exchanges have led to interesting and practical implementation ideas.

Conclusion

Movement from discussion to action is critical. Administrators and teachers must embrace the notion that schools exist to provide the best possible learning for all students. With this belief, curriculum reform takes on new dimensions. Technology must play an integral role in the teaching/learning process so that students are best served now and in the future.

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Developing Customized Media for Preservice Teachers

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In 1990, under the auspices of a Title III grant, the Undergraduate Education Department at Marywood College sought to enhance its teacher preparation program. One proposed outcome for the project was to produce interactive video programs on topics of concern for preservice teachers. During the project's first three years, interactive video programs have been designed by repurposing existing video and producing original video footage.

Repurposing Existing Video

The design and development of interactive video was a new venture for Marywood College. The first step in the process was the formation of a design team. The core of this team, which has remained constant over the four years of the project, consists of an instructional designer, video specialists, computer programmers, and content area specialists. The team members had limited knowledge of how to design and produce an interactive video program. For this reason the first year's project was guided by an instructional technology intern with interactive video expertise and a conscious decision was made to repurpose an existing videodisc rather than produce original video for the first project. By saving production time the team was able to focus on the skills necessary for designing and developing an interactive video project.

Once assembled, the team had to choose a topic for the program. Each year, graduating education majors participate in a formal exit interview during which students reflect on their experience in program. During these interviews, students have consistently requested more information on the topic of classroom management. This request served as a springboard for the needs assessment conducted by the design team.

Student need was examined from several different vantage points. Courses in the education sequence were examined to determine what information on classroom management was disseminated to students. Despite student requests for more information on this topic, a review of evaluation forms showed that student teachers typically received a rating of average or better in the area of classroom management during their student teaching experience. To get a clearer sense of the total picture, the design team surveyed cooperating teachers who had supervised two or more student teachers during the previous five years, first year teachers who graduated from Marywood, and student teachers who were completing the seventh week of a fifteen week student teaching experience. Each were asked to review a list of classroom management skills, check any area which required more attention, and prioritize the items checked. The findings indicated that the majority of participants felt more information was needed on managing inappropriate behaviors, so the team decided to concentrate their efforts on this topic.

With a clear sense of student need, the team began to review existing videodiscs on the topic of classroom management. Much to their surprise, very few discs were found. Those that were on the market did not meet the objectives established for the project. An alternate plan was formulated. Rather than using an existing disc, efforts were concentrated on finding video tapes. The prevailing thought was that if appropriate tapes could be found, the team could seek permission to copy them onto a disc and develop our program accordingly.

Using existing video did have one major draw back — it limited the level of interactivity. The original plan was to give students an opportunity to apply solutions to common classroom management problems and see the consequences of their decisions. The team's ability to follow through on this plan was limited by using existing video. They felt, however, that this could be compensated for in the design of the computer stack.

A set of video tapes produced by Dennis Smith of Memphis State University were chosen for the project. Dr. Smith granted Marywood permission for use of the tapes. To validate content, the tapes were viewed independently by a group of educators. Each person, given a list of segment titles, was asked to check whether the segment depicted a valid example of inappropriate student behavior. Once completed, all forms were reviewed for commonality of response.

Segments chosen by the majority were edited onto a single tape and pressed onto a laserdisc. SuperCard was used to create the text and graphics needed for the computer interface. In a typical sequence for the individual student user, the student watches a simulation of a classroom management problem, chooses a classroom management theory to apply, answers a question concerning how to apply the theory and is given feedback on the answer.

For successful implementation several key tasks had to be accomplished A workstation that allowed for individual, large and small group access was established. Information sheets on how to operate the program were posted at the workstation and lab assistants were trained in the use of the equipment. Faculty were given demonstrations on how the program could be integrated into their course content.

Several problems surfaced as students began using the program. Clarity of directions was the most prevalent problem. The team made several incorrect assumptions concerning the user's skill level. This led to frustration on the part of the user. Lab assistants had to be very familiar with the working of the program so that they could answer questions that arose. Simply providing them with a demonstration was not adequate training. A second problem dealt with the system for logging onto the program. Once students were logged on, if they quit the program in any other manner than the prescribed manner the system would not log off. Consequently, the next person to use the program could not log on. As problems arose, modifications were made to the program and lab assistants were given additional training.

Producing Original Video

As using existing video had limited coverage of classroom management issues, the design team chose to generate original video footage and create a second interactive project on the same topic. After reviewing the research literature on classroom management, members of the design team decided to focus the content of the second interactive video on five preventive classroom management strategies: setting rules, establishing procedures in the classroom, handling transitions, overlapping and with-it-ness.

The first design issue the team had to consider was whether to shoot footage of actual classrooms or stage the scenarios. The framework for the interactive video was designed to present information on each strategy, present video examples and non-examples of the strategies being applied, and assess students' learning. It was decided the best course of action was to stage the classroom scenarios.

Several factors entered into the decision. The program was designed to show both appropriate and inappropriate examples of each technique. Simply turning a camera on in a classroom could not guarantee the quality or appropriateness of the footage. Also, permission to use the tapes would be needed from all participants. Team members did not want to deal with problems that might arise if students did not return the required forms. Staging the vignettes created another set of problems: scripts would need to be written and validated, shooting would need to occur in classroom settings at a time that was not disruptive to the school day, actors needed to be recruited, and the final product would need to have a realistic rather than staged quality.

Scripts were collaboratively written by content experts and school-based educators. Since script writing was a new experience for them, more time than anticipated had to be devoted to this task. What the team found to be most helpful was pairing together a script writer and a team member. The team members knowledge of the program design helped focus the script writer's content.

Once the scripts were approved, arrangements for taping were finalized. Permission was granted by a local private elementary school for the use of classroom space. Taping occurred for two weeks during the summer months. Taping at this time seemed to be a logical decision because the shooting would not be disruptive to the regular classroom activities. However, it did present a problem in recruiting actors.

The team sought the assistance of faculty members and the School for Continuing Education. Faculty from the Communication Arts department had contacts with local high school drama clubs. This contact was instrumental in recruiting actors for several of the video segments. Every summer, the School for Continuing Education sponsors a College for Kids program. Flyers requesting volunteer actors were distributed to students participating in this program. While the response was not overwhelming, the team was able to gather enough actors to stage the remainder of the segments.

Because production was designed in this manner, it was crucial that the taping produced a quality video product that would require minimal reshooting. School based educators were invited to observe the taping of each segment. While observing the taping, they were asked to judge the authenticity of the segment being taped. To validate the accuracy of the completed tapes, student teachers and pre-college teachers were asked to view each segment and, on a scale of one to five, rate the effectiveness of the teacher's technique. Participants in this activity were also given the opportunity to comment on each segment. This information was used to edit and/or reshoot segments deemed inappropriate.

The current status of the project is that support materials are being developed and faculty members are considering how the program best can be integrated into course work.

Lessons Learned

Each process used by the design team offered both strengths and weaknesses. Repurposing allowed the team time to develop the necessary skills and focus on the instructional design process. To produce good interactive video programs sound instructional design is a necessity. The team discovered that repurposing required more up-front time. Time had to be spent reviewing existing materials. One drawback to this approach is that there are no guarantees that appropriate material will be found. If it is found, the issues surrounding copyright must be resolved.

Original video production required a higher level of collaboration among team members, content experts, script writers and academic departments. The team views this collaboration as an overall strength for the project. The key to being successful in shooting original video is using production time efficiently. This requires solid planning in terms of scripting, casting, shooting and editing. Poorly planned efforts lead to inefficient use of production time.

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Lead, Follow and Facilitate: Supporting Faculty Use of Technology

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"Lead, follow or get out of the way" is a familiar slogan imprinted on everything from posters to T-shirts. With a slight twist, the axiom could describe ways that academic computing centers can support faculty use of technology. That is, academic computing sometimes *leads* faculty in the use of technology, sometimes it *follows* faculty initiatives, and always it facilitates the use of technology. In more elegant terms, the support approach used is proactive, reactive or collaborative. As faculty are not always at the same level of technological sophistication, support must be tailored to meet their individual needs. By employing a variety of support strategies, different levels of faculty support can be accommodated. All three types of strategies: proactive, reactive and collaborative are described below with examples of each.

Proactive

The hallmarks of proactive technology support for faculty are knowing about technology innovations, educating faculty about those innovations, suggesting better ways to improve instruction using technology and anticipating needs. Listening to faculty describe ways to improve instruction provides direction to support staff for investigating technologies that might be helpful.

Strategies employed include having laptop computers available for faculty to check out overnight, taping the *Imagine* teleconferences and notifying faculty that these programs area available on videotape, faculty demonstrations of software, and on-campus training sessions held between semesters. In-class demonstrations conducted by academic computing staff for new faculty, free out-of class seminars for students and development of documentation all help to introduce novices to using technology. Demonstrating and using innovations such as e-mail, ASKERIC, Gopher, and presentation software raise faculty awareness of tools to improve productivity and instruction. Usual strategies such as software fairs, faculty-led seminars and presentations, dissemination of free publications such as *Syllabus*, *Query* and Institute for Academic Technology publications, computing newsletters and a services booklet educate faculty about what's available and ways that they might use it to improve instruction.

Proactive strategies also include finding ways to acquire prototypes of innovations so faculty can try them out. Creative use of 30-day trial periods and vendor demonstrations are low cost ways to give faculty and staff the opportunity to actually try software and hardware. Costly mistakes can be avoided by trying things out when a technological innovation doesn't live up to its glitzy promises. Another benefit to trying out software is that it is possible to determine whether or not hardware upgrades are necessary to run the software. Frequently, minimal hardware configurations are specified and do not take into account other uses of hardware. Faculty with creative ideas may need technical expertise in researching equipment needs to write grant proposals. Locating funding opportunities for technology and communicating these to faculty can be helpful in stimulating ideas for improving instruction through technology. Proactive strategies are summed up by demonstrate, communicate and educate — all of which facilitate faculty use of technology.

Listening to faculty ideas was facilitated at Marywood by introducing an enhancement proposal process that enabled departments to formulate plans for improving their curriculum. Not unexpectedly, several proposals involved requests for computer labs. However, the education department planned to improve communication with area school district teachers by proposing a collaborative project to address curricular areas in need of improvement, such as the classroom management skills of preservice teachers. One suggestion made by academic computing was to form a cross-departmental faculty team to produce an interactive video on classroom management. Academic computing staff could provide the programming expertise while the communication arts department would produce the video segments. Education faculty were experts in both instructional design and classroom management and area teachers could be involved in the content validity of the video segments. Thus, process goals for collaboration and a useful instructional product both would be realized.

The next steps were to identify curricular areas in need of improvement, begin faculty training in the particulars of interactive video production and purchase equipment for the production team. Fortunately, the education enhancement proposal became part of a four-year funded grant that enabled the college to bring in a consultant to conduct initial faculty training, acquire hardware and software for production and during the first year support an intern to do the programming. The education proposal did not request funding for the multi-media workstations needed for playback of the completed interactive videos, but academic computing anticipated the need and requested funding for a total of four multi-media workstations to be located in the education curriculum lab and library. Funding was also requested for lab assistants to work with students using interactive video and to assist faculty who wanted to demonstrate use of the interactive video in class. In some ways, the project described above illustrates the hallmarks of a proactive support strategy, but as will be apparent below, as the project developed, faculty initiatives became paramount and support became more reactive.

Reactive

Reactive strategies are characterized by responding to faculty requests or initiatives in using technology. Listening to faculty, evaluating the request and helping to meet their needs is essential. There are two very different kinds of faculty requests that academic computing is asked to support. A common request is to facilitate use of technology in the classroom including ways to learn about possible software for instruction. Another is to support development of new curricular material or support software. It is requests for development of new curricular material that are perhaps the most difficult and time-consuming tasks for academic computing staff. It takes time to program software, and frequently involves spending time with faculty to determine the instructional design of the curricular material and to determine the best match between the technology, hardware and software to meet their needs.

In the multi-year interactive video project, academic computing staff helped the faculty team decide exactly what software and hardware would best meet their needs for production over the four years of the grant. SuperCard software was selected because of the demands of the project's instructional design and its color capabilities. It was agreed that a two-screen interactive video setup would best meet the needs of the project. The videodisc player that was purchased was the highest end one available at the time, a Pioneer 8000 that would do audio over a video freeze frame. The remainder of the funds went for a high end Macintosh (Macintosh IIfx with an 80 MB hard drive and 4 MB of RAM) and color monitor. Not surprisingly, during the first year it was necessary to purchase another 4 MB of memory to be able to run a program for beta testing.

Upon delivery, academic computing staff set up the hardware and installed the software, and then learned that a software driver was necessary to access the videodisc player. During the first year of the project, academic computing staff continued to provide technical assistance to the graduate intern assigned to do the programming, and responded to requests for system setup when the consultant came in for faculty training. By the end of the first year, one academic computing staff member had actually taken over the programming part of the project.

In response to faculty requests, documentation has been written so that students can use the software with a minimum of supervision. Printers were requested and added to the multi-media workstations, again at the request of faculty who wanted students to be able to print out a record of their progress through the interactive video on classroom management. The role of academic computing in the project has gone from being proactive to one of both responding to specific faculty requests and to collaborating on the third video which included a section on ways to use the computer in the classroom, a part of the project on using technology in the classroom. There are, of course other kinds of faculty requests beyond developing new curricular materials. Strategies for responding to faculty requests are discussed next.

The examples of supporting faculty requests for in-class use of technology run the gamut of providing workstations with display panels to providing a means to preview potential software for inclusion in course curriculum. As network access is extended to classrooms, requests for student accounts enabling Internet access to databases such as the clearinghouse for Information Services and other library holdings have become commonplace. From the perspective of academic computing, meeting faculty requests involves maintaining a consistent, up-to-date computer lab environment that may need to be backward compatible to run older software packages, installing and testing software prior to demonstrations in labs and classrooms, and educating faculty about new features of upgraded software so assignments can be updated for consistency. It is always necessary to maintain frequent and timely communication links between faculty and academic computing staff support.

Collaboration

One particularly effective strategy used by Marywood College in support of faculty's use of technology is providing desktop computers in faculty offices. While this may not seem unusually innovative, faculty members must write a proposal outlining their planned use of the computer, software and peripherals and how they will specifically be used to improve instruction for students in classes they teach. These proposals are then ranked by a faculty committee and funded with either grant funds or college capital funds. Support is also available for one year from a graduate assistant who assists with training, researching software packages, conducting classroom demonstrations and developing classroom materials such as spreadsheet and word processing templates. By funding a desktop workstation and software, faculty can familiarize themselves with software before introducing it to students as part of classroom instruction. Faculty are also expected to attend training for 2 days between semesters to learn how to use the basic applications supported by academic computing. This includes word processing, database, spreadsheet, e-mail, CD-ROM searching, and a basic introduction to Internet.

An example of a template that has proved to be very useful to teacher education faculty is a word processing template for lesson plans developed in Microsoft Word using the cell feature. It was developed by academic computing staff and is now on the hard drive or fileserver of all microcomputers so students can use it for all classes that require lesson plans. Documentation for using the template was written by academic computing staff since not all students are familiar with the cell functions in the word processor. Another strategy to support faculty requests for templates is to assign graduate students projects to develop spreadsheet templates for problem-solving exercises that can be used in methods classes for pre-service teachers. Many examples of such templates can be found in professional journals such as *School Science and Mathematics* and *Arithmetic Teacher*.

Future plans for meeting the diverse technological needs of faculty include providing laptop computers for classroom presentations, putting software on the network so faculty can access it from the office, classroom and labs and moving to digital video on CD-ROMs so interactive video demonstrations no longer require moving an entire multimedia workstation to the classroom.

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Making Connections: Transforming Ivory Towers and Little Red School Houses

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Throughout the history of American education, the process of teaching and learning has been a solitary endeavor. In self-contained classrooms, individual teachers and students labor alone, with the teacher being the giver of knowledge and the student being the passive receiver of knowledge. John Goodlad speaks of the "closet of the classroom" when he describes the teacher's work environment. Few teachers, for example, have a telephone on their desks, a communications tool that has been an essential element on the desks of professionals in other occupations for more than fifty years.

Yet improving educational practice is key to our nation's ability to continue its leadership role in the new global community. Graduates from educational institutions must be prepared to accept two primary responsibilities: to embrace the challenges and to harness the collective energy of fellow workers to solve the problems which accompany social, ecological, technological, and economic change.

The teaching of new responsibilities presents new challenges to American schools. To meet these challenges school organizations must seek new answers to fundamental questions such as, "What is good teaching?" What should be taught?" "How do we educate all of our students?" and "What is the role of the teacher in the educational process?"

Our quest for new answers to these age-old questions can best be accomplished through new organizational structures which support collaborative networking within and among universities, schools, and school district offices. The old structures that often relegated teachers to the role of factory assembly-line workers and institutionalized barriers to the free exchange of ideas must be transformed.

This transformation requires a new paradigm for how we teach and learn. Partnerships composed of university, public schools, and other community representatives must envision new learning environments, where teachers and university faculty members work together to "create rather than respond to the future of education" (Glickman, 1990, p. 92) and where teachers are guides and students are active learners. No one doubts that technology must be an integral part of the creation of any paradigm shift, but conflict emerges as to how and when to integrate these technologies.

This paper describes an approach where methods faculty, classroom teachers, corporate representatives, and undergraduate students collaboratively designed and implemented a plan for the use of technology in both the university and the public schools. The approach attempts to answer the following questions: "Why incorporate technology into the existing curriculum?" "How do we begin?" and "What is the impact on the users?"

Introduction

East Carolina University's (ECU) Model Clinical Teaching Program (MCTP) is an award-winning clinical preparation program for selected senior-level elementary education majors designed to help them transfer theory into practice in real classrooms. The program, a successful partnership between the university and Pitt County Schools, creates a teaching/learning context that is conducive to experimentation, reflection, decision-making, and professional growth. The program's aim is to produce a new generation of thoughtful and analytical beginning teachers who are competent, self-assured, and eager to assume their professional responsibilities. Recognizing the importance of technology literacy for prospective teachers, the program has as one of its priorities technology education and staff development for university faculty, public school personnel, and preservice teachers.

Why Incorporate Technology into the Existing Curriculum?

There are three major reasons for teacher education programs to incorporate technologies into professional and specialty area studies. The first is to prepare preservice teachers who can use technology for personal and professional purposes, the second is to prepare preservice teachers to teach their students how to use technologies, and the third is to use technology to change the way we teach and learn.

How do we Begin?

In 1992 the MCTP and the ECU School of Education Technology Committee developed a three-phase plan to incorporate technology into the existing professional and specialty area coursework. The group decided that Phase I would be an orientation to the power of technology and would consist of two primary objectives: informing students and faculty of the technologies available for use in the School of Education and encouraging them to "take the plunge."

To accomplish the first objective, a Technology Awareness Day was arranged. The day was divided into three sessions: "The Technology-Assisted Classroom," "The Use of Technology in Instructional Management," and "The World of Multimedia." Faculty, students, and public school personnel attended lectures and demonstrations that outlined potential uses of existing hardware and software housed in the School of Education's IBM Computer Lab and IBM Model Classroom.

To accomplish the second objective, four MCTP interns, each with minimal knowledge of multimedia production, volunteered to work as a team to produce a multimedia project. Their project, entitled "Teachers, Technology, and Terrific Kids," was accomplished within eight hours and involved the following steps:

Step 1: The interns, using a Canon Zap Shot camera, took photographs which depicted a typical school day in the life of an elementary student.

Step 2: The interns returned to the university campus to digitize the photographs using the Computer-Eyes program on an IBM Model 30 PS/2.

Step 3: Using LinkWay Live and Storyboard Live hypermedia software, the interns sequenced the photographs and synchronized them with background music playing on an IBM CD-Rom drive.

Step 4: They presented their production using computer, CD-Rom, and an LCD panel.

What is the Impact on Users?

None of the interns had prior experience working with any of the hardware or software necessary for completion of the project. The MCTP and Technology Committee had wanted to determine if such a project could be developed within a short time frame by novices and what the reactions of the participants would be. At the end of the "Technology Awareness Day," the interns were asked to share their thoughts about the process and product. The following are intern comments about their first multimedia venture:

> "Working on the multimedia presentation was a thrilling and rewarding experience." (Suzanne Hawkins)
>
> "Being a part of the multimedia presentation was a great learning experience and a lot of fun. Seeing the whole project come together and the group effort put into it was very rewarding." (Bonnie Begg)
>
> "I've had experiences with computers before, but this was one of the most positive and rewarding experiences ever! (Even if it was IBM and I'm an "Apple oriented" person.) The software we worked with was easy and fun to use, and seeing the finished product was great! ... I enjoyed the Technology Day and can't wait to work with another multimedia presentation!" (Karen Morrison)
>
> "Working on the multimedia presentation was fascinating! Being a computer illiterate person, I was very impressed at how quickly the project came together and how much a computer can do. Since the presentation, I have become more aware of the technology at my school placement and here at ECU. I would like to learn more about using technology in the classroom." (Johnna Blair Winstead)

Current Status

Phase II involves networking the MCTP's six elementary schools and the ECU School of Education's computer laboratories and faculty members' offices. Personnel from ECU's Department of Academic Computing and IBM consultants are electronically connecting campus methods professors and university supervisors with cooperating teachers and interns in the field via computer, modem, and telecommunications software. Phase II installation and staff development will be completed during the Spring, 1994 semester. The entire system will be operational by Fall, 1994.

Phase III will focus on integrating technology into existing university methods and elementary school curricula. With training and technical assistance from IBM consultants, university and public school personnel will collaboratively develop technology-enriched units of instruction in language arts, reading, science, and social studies.

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Conclusion

The success of the project's first phase is clearly demonstrated by the interest and enthusiasm of university and public school faculty. The keys its success have been technical support, appropriate hardware and software, necessary staff development, and a willingness to take that first step into the world of technology. University and public school isolation no longer exists here. This project has created a new partnership of teachers and learners who are committed to preparing our teachers for the classrooms of the twenty-first century.

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Integrating Technology into Teacher Education: One University's Approach

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Computer technology has been front and center in the nation's move toward the 21st century. Yet despite the increased availability of state of the art hardware and a proliferation of educational software, computers are receiving only minimal use in many of the nation's schools. According to the U.S. Office of Technology Assessment (1988), one of the major reasons for the limited impact of computers in schools is that many graduates of education programs do not feel prepared to use them. Recognizing the need to better prepare future teachers, we at The American University have begun to integrate technology into several courses in the pre-service teacher education program. This paper summarizes our approach to this task and the resulting philosophy, goals, and procedures that have been implemented, and it concludes with the objectives we hope to address in the future.

We began with a literature review, seeking standards recommended by agencies such as the National Council for Accreditation of Teacher Education (NCATE) and the National Council of Teachers of Mathematics (NCTM). We then conducted a needs assessment to determine campus computing resources and faculty computer skills.

The review of the literature and standards led us to conclude that it would not be possible to incorporate all the desired goals and objectives in the first year. Therefore, just five goals were chosen, as listed below.

Goal I: Explore, evaluate and use computer and technology-based materials.

Goal II: Demonstrate knowledge of uses of computers for problem solving, data collection, information management, communications, presentations, and decision making.

Goal III: Design and develop student learning activities that integrate computing and technology for a variety of student grouping strategies and diverse student populations.

Goal IV: Evaluate, select and integrate technology and computer-based instruction in the curriculum of one's subject area(s) and/or grade levels.

Goal V: Demonstrate skill in using wordprocessing, database, and utility software for professional and personal use.

The University has extensive computer resources, including several special purpose computer laboratories. We selected the Anderson Computing Complex (ACC) for our purposes. The networked Macintosh and IBM compatible computers in the ACC allow students to access the university mainframe for tapping into the library database, sending e-mail, or running software such as Statistical Package for the Social Sciences (SPSS). Liquid Crystal Display panels and overhead projectors are also available in ACC.

Since the networked laboratory setup at Anderson

Computer Complex supports site licenses as well as single station programs, we decided to purchase a variety of software for use there. We purchased site licenses for three programs, five-user lab packs for three programs, and single copies of 20 other programs. Thus we can do demonstrations of single programs using the LCD panel, have all students working with the same program such as *Oregon Trail*, by MECC, or have individual or teams of students working with different software during a single class session.

Wetzel (1993) notes that a combination of a core course in technology and an integration of technology across teacher education courses serves preservice teachers best. Program constraints, however, influenced our decision to incorporate competencies across courses, especially the methods courses, but not require a separate course. Another compelling reason to integrate technology across courses was that prospective teachers should have hands-on experiences within the context of their total teacher education program.

Since all elementary education majors take "Psychology of Education" and "Theories of Reading" at the beginning of their undergraduate elementary programs, the general overview of computers in education and activities related to goals I and II are presented in those classes. The remaining goals are targeted in the methods courses. In these courses, students can meet the objectives in a variety of ways ranging from individual projects to cooperative group projects. They use various software programs in their development of written lesson plans and in micro-teaching demonstrations. Sample activities designed to accomplish each of the five original goals follow:

Goal I. Explore educational software.
Assess available educational software using a 26 item check sheet which covers areas ranging from "user friendliness" to strengths and weaknesses for reading/language arts instruction.

Goal II. Use computers for information management, communications and decision making.
Use spreadsheets to compute grade point averages, class rankings, grade improvement profiles, and graphs for use in parent conferences or PTA presentations.

Goal III. Design and develop learning activities for different settings and/or diverse student needs.
Develop a written lesson plan using a software program for drill and practice in a setting in which there is only one machine in a classroom. For example, how could a teacher use Math Rabbit, by The Learning Company, for individual practice activities?

Goal IV. Integrate computer-based instruction in the curriculum of one's subject area/grade.
Demonstrate or plan a lesson which uses a software program for a small group cooperative learning project. Students working on social studies project about countries in South America might learn how to use various software programs to get information and make maps.

Goal V. Demonstrate skill using computer as a productivity tool.
Use a software program as an administrative tool or to help prepare visual aids for instruction. This could be more work with spreadsheets or learning to do more with word processing and desktop publishing software to generate newsletters, banners, or posters for bulletin boards.

Some goals we consider so important that we incorporate them into several classes. For example, we believe that preservice teachers must become informed users of educational software, therefore in every class students must analyze and select appropriate software. In the course "Teaching Reading in Elementary Education," students are given a 26-item checklist to analyze any of a number of popular reading/language arts programs available in ACC. The checklist covers four major areas: educational value, user friendliness, capabilities, and safe guards. Students have to accept or reject the software based on their checklist answers.

Sometimes several goals can be met in one assignment as is the case in the course "Mathematics for Elementary School Teachers," where goals one, three and four are addressed in one cooperative learning activity. Four teams of students design lesson plans using various software packages. The first team focuses on selecting and using programs for drill and practice. The second team looks for problem-solving or simulation activities for small groups. A third team looks at programs that lend themselves to large group activities for mathematics instruction. A fourth team looks at programs in social studies or science to determine ways of integrating mathematical activities into lessons using those programs. Each team conducts a simulated lesson before fellow classmates who roleplay elementary students. They must address the question of how they would use their programs according to access, i.e., a one computer classroom versus a laboratory with multiple stations.

In the 1993-94 academic year, we have been developing and field-testing lessons and activities in various courses. By 1994-95, we hope to have these activities and assignments fully integrated into the basic courses.

Future Directions

We have already chosen a second set of five goals for future lesson development. Students shall be able to:

Goal I: Demonstrate knowledge of equity, ethical, legal and human issues of computing and technology use as they relate to society and model appropriate behaviors.

Goal II: Demonstrate a functional knowledge of a programming language such as BASIC or Logo.

Goal III: Demonstrate a functional knowledge of telecommunications tools and resources such as electronic mail and the Internet.

Goal IV: Possess knowledge of the configuration of computer hardware systems and basic troubleshooting and maintenance of hardware and software.

Goal V: Demonstrate functional knowledge of multimedia and hypermedia tools and resources.

Conclusion

We believe micro-computers are tools that all prospective teachers need to be able to use with confidence. Computers are such an integral part of today's society that schools cannot afford to have them sit idle or be used infrequently. Schools of Education must take an active role in researching and using this technology and incorporating it into the fundamentals of classroom management and instructional modes. We believe our approach at program-wide integration of behavioral and cognitive objectives in a systematic way is a fundamentally sound approach to making teacher training relevant and creative.

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The Implementation of Technology in an Elementary Teacher Certification Program

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"It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system."

Machiavelli's 17th century words describe the 1993-94 year in the Education Department at St. Mary's University, a small liberal arts institution established in 1893 which serves a 70% minority population. During past few years the university's seven member education department has been well aware of the critical instructional changes needed to prepare classroom teachers, school administrators, and teacher educators who can effectively work with San Antonio's "at risk" and multicultural populations.

In the fall of 1993 the Texas Education Agency awarded $1.9 million to five San Antonio colleges to establish the Center for Educational Development and Excellence (CEDE). CEDE represents an unparalleled collaboration among five independent school districts, the five institutions of higher education, the Region XX Education Service Center, the local community college district and the San Antonio business community. CEDE was established to better prepare the classroom teachers, school administrators and teacher educators needed to meet the needs of the city's multicultural school population.

Challenged by this unique opportunity to become part of the "technological revolution," St. Mary's made a commitment to encourage faculty members and preservice teachers to become facilitators of learning rather than deliverers of information. Implementing this goal necessitated the coordinated efforts of faculty, preservice teachers, practicing teachers, administrators, and Region XX staff. Special emphasis was placed upon the formation of working partnerships with schools that were identified by the Texas Education Agency in 1993 as "un-acceptable". Since this was to be a true collaborative, it was planned to use the extensive pool of knowledge and experiences of all participants to provide the framework for change needed to prepare personnel with an understanding of critical thinking skills and effective methods for working with at-risk students.

University Faculty

The objectives of CEDE required a commitment on the part of each faculty member in the education department. As Beaver (1990) pointed out, much of the problem in undergraduate educational technology is the educators, the faculty of higher education. He stated that a void exists in the training that they have received. This void is then passed on to their students.

The lack of an existing, integrated and long term policy for raising the university faculty's technological expertise had permitted a haphazard evolution to occur. Technology-literate faculty members investigated new materials while some faculty tried self-initiated study, some sought peer assistance, and others did little. All members stated concerns about including computer applications within their current coursework. One commented, "not enough time to teach a regular course and technology, too – the learning curve for both instructor and students is slow."

This was a rocky foundation on which to begin building a technological model of instruction. Therefore, faculty training was identified as a primary need.

A disastrous first inservice was conducted by an "expert" who attempted to teach *Toolbook* in a short period of time to a fledgling faculty group. Later, more successful, sessions on topics ranging from *Introduction to DOS to Advanced TENET* and *HyperCard* were scheduled at the local educational service center and conducted by persons skilled in computer implementation as well as educational methodology. Faculty were encouraged to participate in the inservice program, use this instruction to develop active learning environments, and model appropriate uses of technology in their classes.

Three set-backs occurred during this period. First, lightning struck the Administration building during a summer storm. All faculty computer boards were "fried" and network lines knocked out. Damages were not discovered until the faculty returned to campus in late summer and found machines not in operation and research data destroyed. This was a very time-consuming way to learn the necessity for backing up data files.

The second incident was a session that was to instruct in the use of multimedia equipment. Again, an expert presented materials not consistent with the objectives of the session. St. Mary's collaborative motto might become"BEWARE OF EXPERTS!"

A third difficulty was discovered as we tried to install new software and equipment. When nothing seemed to work, technicians discovered our new machines had been "hit" by a virus. We are now obtaining anti-virus programs.

On the more positive side, one professor used a notebook computer and LCD projection panel to present a talk at a meeting of the St. Mary's President's Peace Commission. Positive responses by the audience toward this use of technology have prompted other departmental members to request training and access to this equipment.

Preservice Teachers

The establishment of a campus computer laboratory spurred some professors to take the next step in the program: planning a curriculum for preservice teachers. Discussions with education students revealed that they had prior introductions to computers (and, typically, wordprocessing) in high school and while taking the university's required *Introduction to Computers* course.

A survey was distributed to 54 students in St. Mary's teacher certification program to determine their perceptions of current competence, previous experience using computers in schools, and interest in developing educational computing expertise. Students used a five-point scale to rate statements in a ascending progression from 1 (low), to 5 (high). The results, shown in Table 1, indicate that students perceived themselves to have a low to moderate knowledge of computers and a moderately high to high (positive) attitude toward using computers in their instruction.

Bringing Computer Technology into the Teacher Education Curriculum Turner (1989) presents three models for preparing teachers to effectively use computers in their classrooms: (1) the assumption model—students will pick-up information on their own; (2) the three-unit semester educational computing course model; and (3) the integration model—where technology is integrated into methods and teaching courses. St. Mary's choice was to adopt the integration model. Experiences are planned throughout the teacher education program to provide preservice teachers with:

(1) opportunities to learn about and use technology;

(2) an awareness of and exposure to all types of technology, including audio/video recording, telecommunications, information retrieval, computer-assisted instruction and productivity tools;

Table 1
Preservice Teacher Expertise, Experience, and Interest (N = 54)

	Average Score (5 point scale)
Prior knowledge of computers	3.2
Interest in implementing ed computing in education	4.3
Competence in implementing ed computing	2.9
Interaction with computer technology in preservice core classes	2.7
Interaction with computer technology in preservice education classes	2.5
Interaction with computer technology during field experience	1.8
Use of skill development software during student teaching	—
Use of critical analysis software during field experiences	1.7
Use of critical analysis software during student teaching	—
Interest in using computer technology in your classroom to develop and reinforce skills	4.2
Interest in using computer programs to encourage development of thinking skills	4.4
Positive attitude toward using computers to increase student motivation	4.4
Positive attitude toward using computers to promote critical analysis and thinking skills	4.3

(3) knowledge of how to select, critique, and use appropriate tools in a way consistent with their teaching style; and
(4) an understanding of issues involved in educational computing.

Computer usage was introduced into the Language Arts course via a software package entitled "Once Upon a Time." This program was chosen because it supports a goal of the class which is to model connections between the reading and writing processes. Successful usage encouraged the professors to mesh other software which promotes critical analysis into their instruction. These new programs will be introduced during the spring 1994 semester.

A series of workshops to introduce preservice students to various computer applications are underway. One workshop was offered prior to the students' social studies field experience. It was conducted by the cohort school district's technology coordinator and a university professor. The social studies field experience requires students to develop unit plans and daily lesson plans which incorporate such strategies as cooperative learning and the use of appropriate instructional technologies. The students were eager to use their technology-based instructional plans, and most were disappointed that they were not provided classroom opportunities to do so.

In another session, preservice students were introduced and given access to electronic mail and TENET, the enhanced electronic communication network that transmits information to members of the public education system in Texas and throughout the world through the Internet. It is expected that knowledge gained from leading these workshops will provide university personnel with the framework for a newly conceived three-unit class designed to provide instruction in technology used in education.

Inservice Teachers

Technology has the potential to enhance, expand and change the way we educate students; but this potential can only be met if classroom teachers enthusiastically adopt technology-based instructional methods. Lack of knowledge, experience, resources, time, and pressures to improve test scores are all used as excuses for failure to utilize technology in instruction.

Teachers' adoption of technology-based methods is not a rapidly paced transformation. Sheingold (1991) reports that teachers need five to six years experience in teaching with computers and extended class periods to effectively use technology-based, hands-on learning activities. As they adjust to the new methods, they become coaches and facilitators of learning rather than dispensers of information. Inservice education to facilitate this transformation must be on-going and based on teacher needs. It must encourage teachers to take risks and go beyond using computers for the prevalent drill and practice exercises.

St. Mary's Education Department developed an action plan which addresses these requirements. The university's students would become change agents and catalysts for class restructuring by including technology-based methods in the instruction they deliver during their field experiences. Students would share experiences, supply new ideas, rehearse lessons, and serve as a supportive audience as new roles are embraced by both preservice and inservice teachers.

University sponsored workshops are presented for inservice school personnel when need is identified. One faculty member developed and presented a workshop entitled "Portfolio Assessment in Ungraded Classes" when a group of public-school teachers working in such a setting voiced a need. The professor not only provided information but helped map new directions and maintained contact with teachers as they implemented materials.

The collaborative has provided additional technology equipment to cohort schools and financed training opportunities, TENET accounts, attendance at conferences, and the means to have representatives from cohort schools participate in CEDE decision-making meetings.

Current Status

Faculty members are anxiously awaiting the installation of "Down Links" during spring, 1994. Pilot plans are being developed to use interactive videos, additional training in multimedia usage, a Tom Snyder workshop, and extensive use of laservideo discs by preservice students during their science field experiences. Instead of interacting with one group on one campus, participants will be able to share knowledge with multiple groups.

The CEDE collaborative has learned the on-going necessity of defining goals; establishing standards; developing short and long range plans; assigning responsibility; coordinating programs; developing revised curricula, staff training, and a system that evaluates these steps in a continuous manner. These steps provide a basis for further development, however, we must remember that teachers tend to teach as they were taught, so our efforts must not become relaxed.

SMALL STEPS LEAD TO GREAT STRIDES

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Redefining Educational Leadership: What Principals Can Do to Advance Technology in Education

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The importance of the school principal as an instructional leader, or change agent, has been well documented in the literature (Blumberg & Greenfield, 1986; Bossert, Dwyer, Rowan, & Lee, 1982; Sweeney, 1982; Lightfoot, 1983; Dwyer, 1984; and Little & Bird, 1987). As schools are increasingly influenced by the influx of new technologies into society, school administrators' attitudes and actions become more important than ever before to the future of education. A new vision of technology's place in education is required if teachers and students are to develop the skills necessary to meet the challenges of the 21st Century.

As teachers and students attempt to integrate new technology into teaching and learning practices, the role of the school principal becomes critical to the successful implementation of advanced innovations. The purpose of this paper is to redefine educational leadership within a technological paradigm. A set of interactive models for advancing technology in the schools is presented, providing a holistic view of the complexities faced by administrators who choose to meet the technological challenge.

The Challenge

Today's students must develop knowledge and skills that will enable them to compete in a complex global economy. The private sector demands a technologically literate, skilled work force to remain competitive in the world marketplace (Choquette, 1987). The American educational system must prepare sufficient numbers of graduates capable of succeeding in our rapidly changing, high-tech, information-oriented society.

School principals must take leadership roles in educational reform measures that will lead to more effective schools. Principals cannot succeed, however, by using management and leadership strategies which do not support the integration of information technology into classroom practices. Today's administrators must be knowledgeable users of technology themselves and effective managers of technology in their schools. Unfortunately, studies have shown that the majority of principals have not had first-hand experience using technology in the classroom nor was technology training part of their teacher or administrator program (Casey, 1993). As a result, many find themselves facing technological challenges for which they are not prepared.

The Framework for Change

What considerations must be made to effectively plan, implement, and maintain a technologically integrated educational program? The first consideration should be the environmental framework in which the program will exist. This framework, as shown in Figure 1, consists of both internal and external environmental factors including sociopolitical influences, legal mandates, and economic conditions. These factors, considered within a school's cultural and physical environment, will influence the direction and pace of technological program development and implementation. It is important for principals to recognize these influences. It is even more important, however, that principals develop a plan to minimize negative influences

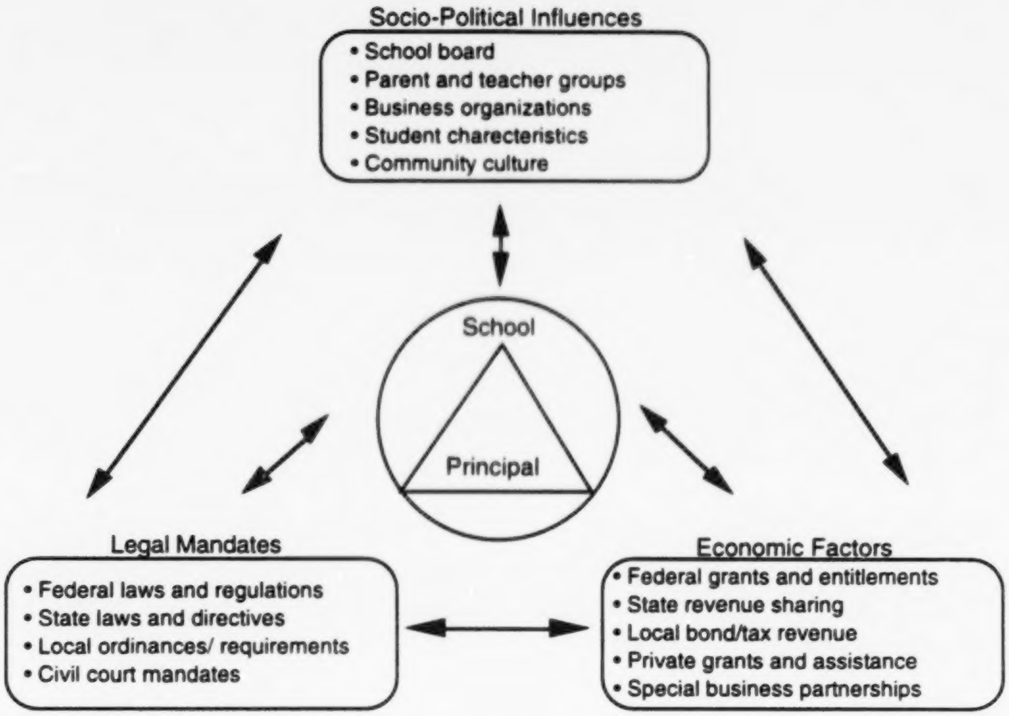
Socio-Political Influences
• School board
• Parent and teacher groups
• Business organizations
• Student charecteristics
• Community culture
School
Principal
Legal Mandates
• Federal laws and regulations
• State laws and directives
• Local ordinances/ requirements
• Civil court mandates
Economic Factors
• Federal grants and entitlements
• State revenue sharing
• Local bond/tax revenue
• Private grants and assistance
• Special business partnerships

Figure 1
Environmental Framework for Decision Making

and maximize positive opportunities which will promote technology in the school.

Effective Principals Within a Technological Context

An extensive body of research suggests that principals' decision making and actions, within the context described above, fall into five essential categories. These categories include defining and communicating a mission, managing curriculum and instruction, training and evaluating teachers, monitoring student progress, and promoting an effective instructional climate (Krug, 1993). This author suggests that an essential sixth category, managing technology, be included to define these broad levels of organization.

Figure 2 illustrates this concept.

Defining and Communicating a Mission

Research has shown that most principals are strong supporters of the notion that instructional technology is good for education (Bennett, 1994; Woodward & Mathinos, 1987). Research has also shown, however, that most administrators are not moving their schools forward to integrate technology into the curriculum and teaching practices (O.T.A., 1988; Preston, 1990; Waxman & Huang, 1993). This gap between what principals think is a good idea and its implementation exists for one or a combination of the following reasons: district/school philosophy and goals do not emphasize the importance of technology in education; philosophy and goals are technologically well defined, but principals don't know how to reach them or don't have a budget to support them.

A well-defined mission which describes technology's place in education is critical to the success of a school because the use of technology is critical to the success of students in their everyday lives. Our educational mission should be to integrate the real world into our schools so students' educational experiences meaningfully mesh with all other aspects of their lives. It is the responsibility of the principal to define a mission that makes school a part of the real world. A principal's vision of education should not only be of the future, but of the present. What are students doing in school that is useful and meaningful to them today? All too often, technology is seen by educators only as a futuristic concept hovering on the educational horizon and computers remain unplugged in back corners of classrooms. Meanwhile, in the "real world" students interact with computer technology everyday.

Once a technological mission is clearly defined, it must be effectively communicated. School administrators need to send a strong, repeated message emphasizing the importance of technology to teachers, students, parents, and

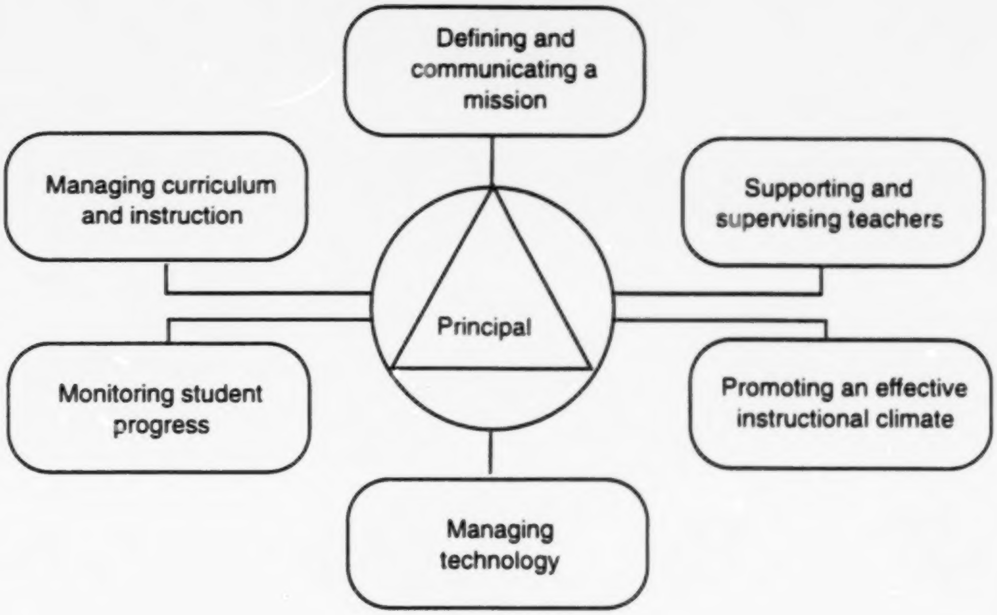
Defining and communicating a mission
Managing curriculum and instruction
Supporting and supervising teachers
Principal
Monitoring student progress
Promoting an effective instructional climate
Managing technology

Figure 2
Catagories of Tasks Performed by the Effective Principal

community and business organizations. Collaborative goal setting and planning must ensue. Most importantly, principals must model the message by becoming active participants in whatever programs are established.

Managing Curriculum and Instruction

As instructional leaders, principals must act on their vision of technology in education. If the integration of computers into curriculum and instruction is a goal, then the principal must determine not only what hardware and software exists in the building, but how and if it is being used. The under-utilization of computers and software, as well as the manner in which they are mostly used in the classroom (e.g. drill, practice, and gaming), promotes the viewpoint that computers, like overhead projectors, are helpful tools to support existing instructional practices, but not important.

If computers are not being used, then it's time to repeat the message that computer use is an important part of the teaching and learning process. If computers are being used solely as drill and practice tools rather than for process-oriented uses (e.g. computer-based writing, reading comprehension, problem solving, hypothesizing, generalizing, etc.), then it's time to support teachers in reaching more sophisticated levels or usage. Based on their study of computer uses in education, Woodward & Mathinos (1987) suggest that principals take steps "to create a bridge that would allow teachers to move from very utilitarian, familiar computer applications to those that would truly effect fundamental change in how teachers teach and students learn (p. 6)."

Effective principals know not only what various technological hardware and software is capable of doing, but also how it can be used effectively in the classroom. Hardware and software selection should be based on teaching goals and regular classroom activities. Principals can get helpful information from professional organizations or reviewing journals that regularly evaluate new instructional technology. Another good source of information is other school principals and teachers who have tried different technologies and strategies to integrate them into curriculum and instruction.

Supporting and Supervising Teachers

Like administrator training programs, few teacher education programs offer enough courses in instructional technology to prepare teachers to effectively use new technology in the classroom. Therefore, teachers must be given inservice support, training, and time to accomplish technological goals and objectives. A statewide study of computer uses in Oregon's secondary schools conducted by Lamon & Sanner (1989) found that one reason teachers did not make effective use of microcomputers in the classroom was lack of time available to them to investigate, evaluate, and plan for the use of software. Another reason was that teachers did not have time for integration of computers into their lessons and not enough classroom time to fit computers into instruction. These findings imply that principals must re conceptualize teachers' schedules and responsibilities within a time framework that sets technology use and training as a high priority.

Technology-oriented schools are those in which teachers have access to equipment and software (Lamon & Sanner, 1989). Inservice training that provides follow-up technical support is most effective for encouraging the actual integration of technology into teaching practices (Bennett, 1993). According to Winkler & Stasz (1985), technical support is the most important, but least commonly found, type of teacher incentive that promotes more widespread use of computers in the classroom. Since application and practice of new technological skills is essential, principals should conceptualize a plan that will allow teachers to borrow school computers and software for use at home.

Instructional supervision is an ongoing process which provides teachers with feedback on their teaching skills. If teachers are expected to creatively use technology to enhance instruction, then the school principal must be prepared to evaluate the effectiveness of instructional methods. It is very difficult to evaluate teachers' use of technology without a firm grasp of technological knowledge, skills, and applications which are possible.

Monitoring Student Progress

Technology offers today's administrators an opportunity to easily manage information and track the progress of students. A key to solving academic and behavioral problems is early detection and intervention. When properly programmed, computer-assisted management tools can alert administrators to at-risk student academic or behavioral indicators long before major problems would mandate a trip to the principal's office. Technology offers a platform where teachers, counselors, teacher aides, and other school personnel can quickly access student information and promptly provide assistance. Data base management programs perform tasks such as keeping school attendance records, generating grade reports, and maintaining permanent student records.

Promoting an Effective Instructional Climate

The effective technological administrator asks teachers what they are doing to prepare students for today's world and sets a school climate for their success. Instruction can improve through ERIC searches for relevant research, communicating through E-mail with other schools, sharing information through electronic bulletin boards, and participation in the wide variety of educational information and discussion groups offered through Internet.

Teachers should be encouraged to collaborate in the use of these resources, to exchange information, and to assist each other as they strive to develop new technological skills. Staff meetings need to have time set aside for teachers to share insights, strategies, successes, and failures as they attempt to integrate technology into their classrooms.

By setting a common goal and providing a forum for sharing, principals can promote the development of close, personal, and collegial working relationships among teachers. These positive relationships strongly influence the learning climate of the school.

Managing Technology

This category of administrative tasks is new to many principals who ask themselves, "How can you manage something you don't understand?" The answer is, "You can't." In order to manage this most important piece of America's educational puzzle, principals must know what the various components of a technological educational system are, how much they cost, and what their impact will be on teaching and learning. Today's principals must reconceptualize and redefine their leadership roles within a technological paradigm by addressing the following questions:

1. What is your plan to become an informed, fluent user of technology? What steps will you take to establish and update your knowledge of current uses of technology in education?
2. Is your school's technological mission clearly defined? If so, have you clearly articulated your visions to students, parents, teachers, community, and business support groups?
3. Have teachers and other potential supporters been involved in goal setting and long range planning?
4. What is the current status of computer and technology literacy in the school?
5. Is a plan in place that will lead to the integration of technology into curriculum and instruction, going beyond use of computers for games, drill, and practice?
6. Do teachers and students have adequate access to hardware and software?
7. Have ample funds for inservice training been set aside to provide for qualified trainers and teacher release time?
8. Specifically, how will you evaluate whether teachers are effectively integrating technology into curriculum and instruction?
9. How will you "practice what you preach"? What behaviors will you model for students and staff in your use of various technologies?
10. What specific steps will you take to network teachers, and students, both within the school and with others outside your school?
11. What is your plan to assist office support staff in adopting pertinent technology that will help administrative tasks run smoothly? Is office hardware and software compatible with that used by teachers?
12. Have you considered how your student knowledge base fits into the next level of education? Do elementary schools use computers and software that are consistent with usage in your middle schools, high schools, etc.?
13. What expenditures on technology offer the most educational opportunities for your school's specific needs within limited budgets?

Conclusion

Today's principals must take a leadership role in the advancement of technology in education. They must rethink teaching and learning within a new paradigm to prepare students for the challenges of today and tomorrow. Within the context of a changing technological world, principals need to understand the capabilities of educational hardware and software in order to intelligently guide teachers and students in their use. Principals must be wise leaders and wise shoppers in an increasingly technical and monetarily tight educational arena.

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A Tale of Computer Use at Three Elementary Schools: Implications for Teacher Educators

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While much has been written about the potential of computers to enhance teaching and learning, recent reports suggest that K-12 schools are relatively unaffected by new information technologies. Commonly cited reasons include inadequate computer resources, lack of teacher preparation, lack of planning time, and lack of on-site support. One study (Strudler & Gall, 1988) documents ways in which effective computer coordinators helped schools to overcome these impediments to computer implementation. The three case studies revealed that school-based computer coordinators use a combination of product- and client-centered strategies to facilitate computer use. Interestingly, the coordinators in that study all saw their role as transitional and expected to "work themselves out of their jobs" within two to five years.

This paper describes a follow-up study that examined what happened at the same three elementary schools with regard to the use of technology during the past seven years. It then discusses the implications of those findings for teacher educators. How have the roles of the coordinator's changed and what outcomes were they able to effect? Were the coordinators indeed able to "work themselves out of their jobs?" While the initial study yielded some promising findings, much can be learned from examining what has evolved over time in those schools and reflecting on the implications of those findings for teacher educators.

Methods

This study employed a case study design that used questionnaires, interviews, observations, and the review of relevant documents to examine the work of three computer coordinators and the implementation of computers at their schools. The sample consisted of the same three elementary schools that were examined in the initial study. In 1986, a sample of three schools was selected because their coordinators had been identified as having brought about a high degree of implementation of educational computing. In May, 1993, all of the coordinators were still working at their respective schools.

Three interview schedules pertaining to the role and qualities of the coordinators were administered. Informants included the coordinators, their supervisors (principals and district computer coordinator), and their clients (the teachers in their schools). Forty-two interviews were conducted, ranging from twenty-five minutes to two hours in length. Further data were gathered by direct observation of instruction and analysis of planning documents. The data were collected over a three-week period. Using the case study method suggested by Yin (1989), multiple sources of data were used allowing for validity checks on the reported strategies and achieved outcomes.

All 42 interviews were tape recorded and transcribed. Field notes and interview data were analyzed in an open fashion, searching for salient themes pertaining to the work of the coordinators and the efforts of teachers to implement technology in their schools. The data were analyzed case by case, and then across cases.

Results

Preliminary data analysis suggests that school finances have had a clear impact on the findings of this study. This clearly reflects the national trend in which Americans cite proper financial support as the number one problem facing the public schools (Elan, Rose and Gallup, 1993). Of the three schools which had allocated released time in 1986 for the coordinators to perform their role (an average of .43 of a full time equivalent), only one has been able to maintain any released time for its coordinator. Below is a brief analysis of each case, followed by a discussion of preliminary findings that have emerged across cases.

At West School, one of the schools that lost it's released coordinator, data suggest the computer lab is tightly scheduled and used by a majority of the teachers at that school. Whereas early goals were on the integration of computer-based tools into the curriculum, teachers now indicate that the main goal of the program is skill reinforcement (i.e., drill and practice). Since no one is now working to expand and maintain the software collection, the teachers have accepted working with the "well established" lab sets of older MECC software. There appears to be consensus that a coordinator is still needed to organize and maintain the lab's hardware and software, and to help teachers keep up with new programs and applications. All agreed that the program had declined without a coordinator and most predicted that it probably would continue to do so.

East School also has discontinued support for it's coordinator position. Teachers report that some of the responsibilities of the coordinator were distributed among the faculty and the lab functioned adequately for two years without a coordinator. In June of last year, however, the staff reached consensus that the lab be disassembled and the computers placed in the classrooms. The need to secure an additional classroom prompted this decision, but many of the teachers favored having computers in their rooms. While most would prefer having a lab with a released-time coordinator, they recognize that such an arrangement is no longer possible amidst the budget cuts. Many are optimistic, though, about having computers in their classrooms, but they continue to cite the need for help in learning about new software and technologies, and methods for using them with the available resources.

Central School, which still has a released coordinator (.4 full time equivalent in 1992-93, .3 in 1993-94), appears to be thriving with computer use well woven into the fabric of the school. In many respects, what is occurring at Central can be viewed as a realization of the vision of its computer coordinator. Early on in the program, the coordinator asserted that computers should be integrated into all subject areas and that she would help teachers to do that as an "on-site staff developer," not a computer teacher. While she still models lessons using new programs with students, the teachers accompany their students into the lab and follow up her lessons in their scheduled lab times when the coordinator is not available. In addition, all teachers have at least one computer in their room to further enhance their curriculum. Computer use covers a wide range of applications including skill reinforcement, problem solving, and a variety of tool uses. Furthermore, the integration of computers at Central seems to have raised the collective self concept of the school, and the teachers strongly support the work of the coordinator as she keeps the established program rolling while she explores the "next steps" (telecommunications, multimedia, etc.). The staff appears to have reached a comfort level, but after seven years, the coordinator has not "worked herself out of a job."

Results across cases suggest that while most teachers are "sold" on the potential of teaching and learning with computers, they frequently cite problems that must be addressed before this potential is realized. As was documented in the initial study (Strudler & Gall, 1988), coordinators perform a variety of functions that help schools overcome impediments such as lack of computer resources, teacher preparation, planning time, and on-site support. Data from the present study further support the notion that reducing the impediments to the implementation of computers will not likely occur without adequate time for coordinators to perform their role. This involves managing a myriad of details and providing the leadership necessary for teachers to establish a shared vision and school plan. Finally, the data suggest that effective models, such as the one employed at Central, will be not easily exportable as a whole. The process of change with technology is complex and appears very dependent upon the skills of the coordinator and the dynamics of the school context.

Implications for Teacher Educators

The findings of this study pose interesting implications for teacher educators. First, what can be done to help preservice and inservice teachers better cope with the difficulty of implementing technology-based change in times of dwindling funds for on-site support? What strategies might enable teachers to be more effective as agents of technology-based change? Another set of issues centers around our work with college of education faculty who are seeking to integrate technology into their teaching. What parallels exist between the impediments to integrating technology at the university level and those reported by elementary teachers? Do education faculty require the same type of on-site support as was described by classroom teachers? Will those performing coordinating roles in colleges of education experience similar difficulties in "working themselves out of a job" as did their elementary counterparts? A discussion of these implications follows.

Classroom Teachers as Change Agents

Though technology coordinators perform a variety of functions that facilitate classroom teachers' use of technology, budget realities suggest that we cannot count on that support and leadership to be widely funded. Even if technology coordinators are staffed, it makes sense to prepare a broad base of teachers who are oriented toward being change agents in their schools. Fullan (1993) writes:

> In addition to the need to make moral purpose [i.e., the will to make a difference] more explicit, educators need the tools to engage in change productively. Moral purpose keeps teachers close to the needs of children and youth; change agentry causes them to

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> develop better strategies for accomplishing their moral goals (p. 12).

One way for teacher educators to support this notion is to make explicit the goals and skills of change agentry. Particularly pertaining to the use of technology, teachers need to explore both the realities of today's classrooms (i.e., with limited computer resources and on-site support, teachers who are resistant to change, etc.) as well as the dreams of what will be possible in the coming years. Papert (1993) supports this approach. "What is certainly of no value whatsoever for those interested in change," he states, "is to play down the adverse factors: Only by understanding them can we craft sensible strategies for the future."

Sarason, in a recent book, echoes this change theme. "I am advocating that they [teachers] become agents of school change, that they not see themselves as powerless victims of an uncomprehending public (pp. 127 -128). He then elaborates on what he sees as the responsibilities of teacher educators:

> The preparation of educators should have two related, and even conflicting goals; to prepare people for the realities of schooling, and to provide them with a conceptual and attitudinal basis for coping with and seeking to alter those realities...(p. 129).

The Need for Teacher Leaders

A related theme involves the need for course work for technology coordinators and teacher leaders that explicitly focuses on the change process. One approach that addresses these needs involves employing action research to help teachers gain insight into the process of school change. Among its many benefits, action research provides teachers with a real reason to connect theory and practice and a user friendly structure within which to frame problems and explore solutions. Supplemented with support groups for teachers to discuss their projects, action research appears to be a promising activity for enhancing leadership skills for teachers seeking to effect technology-based change (Strudler and Powell, 1993).

Education Faculty as Change Agents: Selling the Vision

Impediments to expanded use of technology in schools can be overcome if educators with a vision help to "sell" it to others. Papert suggests that we learn from the past, such as the case of the new math movement. He explains (1993), "Not only did the new math movement fail to please parents, but the instigators of the movement did not even consider this to be a relevant factor" (p. 220).

Gardner adds that educational reform depends equally on four different nodes: assessment, curriculum, teacher education, and community support. He also states that "educators must share their vision with members of the community..." (p. 255). Whether the reform in question be whole language, hands-on math, inquiry-based science, or the integration of technology-based tools, it seems that teacher educators can contribute to the success of these innovations by proactively selling their vision to school personnel and community members. While the "windows of opportunity" for school reform appear to be ajar and perhaps"back to basics" reactions always lurk close by.

What About Our Own House?

Many of the findings pertaining to elementary schools appear quite relevant for colleges of education. For one thing, the time demands of learning about and evaluating new programs and technologies will always be a challenge at both levels. As access to user-friendly computer resources increases, however, education faculty will likely make technology a higher priority. Meanwhile, many teacher educators are still in an awkward transitional period in which the benefits of teaching and learning with technology do not necessarily outweigh the costs. This, of course, varies from site to site. As at the elementary level, a knowledgeable coordinator can help faculty become familiar with what is available that fits their program. Over time, as technology becomes a higher priority for faculty, the need for such coordination and leadership will probably decline. Similar to the elementary setting, however, it seems unlikely that those who perform coordinating roles in colleges of education will "work themselves out of a job" any time soon. At both levels, progress with technology will continue to require committed and skilled agents of change.

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Multimedia in Teacher Education: Coping with the Human Element

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The current information revolution is comparable in importance to the industrial revolution of the 18th and 19th century although there are obvious differences in content, process, and pace. The implications of the information revolution for education are far reaching. To date in education, most commonly used technological advances in information management involve text-based applications. The incorporation of other media into education is still in its infancy. (For the purposes of this paper, the use of various media offering user control through computers will be referred to as multimedia.) This contention is supported by looking at the volume numbers of journals related to the use of multimedia in education. There are a few journals with a broad focus on technology that are in their 20th year of publication (e.g. *Technological Horizons in Education*, 20), but most of the journals concerned specifically with multimedia are in their second to fifth year of publication (e.g. *Educational Technology Research and Development*, 4; *The Journal of Multimedia and Hypermedia*, 2; *Multimedia Review*, 3).

The reluctance of public education to research and explore the uses of multimedia is not mirrored in the business world. *MacWeek* recently had three articles detailing multimedia educational projects developed by businesses for various applications. One of them (Rosenthal, 1992) reported on multimedia training. The American Airlines Learning Center in Fort Worth, TX coordinates the use of laserdisc audio and visual images with "live" instructors to teach several different types of courses. Reported advantages include both an increase in the amount of information covered and a decrease in the amount of time required. Boeing trains more than 5,000 maintenance workers each year using a multimedia format. It reports the strength of visual images in overcoming cultural barriers to communication. Kobe Steel of Japan uses multimedia to simulate various production techniques and to get past language barriers in its sales presentations. There are numerous other applications of multimedia to educational problems in business contexts.

Multimedia in Teacher Education

There are various projects and applications today that are using multimedia for educational purposes. Marcus, Nicholson, and Phillips (1991) listed 20 different projects underway at the University of California at Santa Barbara, which is noted as a leader in the field of multimedia. Noticeably missing in the list of projects was any mention of the college of education. Education at the university level may be lagging behind the business world in its use of multimedia, but the education of teachers is apparently lagging even further behind in this effort. A review of the 1992 issues of *Technological Horizons in Education* (vol. 19), showed only one out of approximately 48 feature articles that dealt with the incorporation of multimedia into teacher education; the focus of this article was on distance education rather than capitalizing on the unique qualities of multimedia to enhance the education of preservice teachers.

A similar review of articles from *Syllabus* on the use of Macintosh computers in higher education by the content areas yielded the following table. (*Syllabus* is a journal produced by Apple for Macintosh users in higher education)

Table 1
Number of articles by discipline in the 1990-1991 volume of *Syllabus*.

1	Art
1	Journalism
2	Political Science
3	History
4	Music
5	Physics
9	Humanities
11	Chemistry
12	Science
17	Language
17	Psychology
26	Biology
34	Education
49	Medical and Life Sciences
50	Business
54	Engineering
58	Computer Science
94	Math and Statistics

Education is sixth in number of articles dealing with computer applications. Many would argue that it should be at the top because it effects all other disciplines.

Falk and Carlson (1992) state the importance of multimedia and deplore the lack of its use in public schools. They also suggest that since most teachers teach as they were taught, the use of multimedia in public education is not likely to increase dramatically until it is routinely incorporated into the instruction of preservice teachers by teacher training institutions. More and more teacher training institutions are incorporating sophisticated classes on applications of technology including multimedia in classrooms. However, the incorporation of multimedia into methods, foundations, and other educational classes is slow.

In summary, because of the current information revolution, educators have at their disposal more powerful tools for education than ever before. Unfortunately, these tools are not being widely used in teacher education. Multimedia affords the potential for powerful tools that allow us to teach specific instructional techniques and models with unparalleled precision and vividness.

The Change Process in Education

Change in education has been systematically studied for at lease 20 years (Fuller, 1969; Hall, Loucks, Rutherford, and Newlove, 1975; Hall, Wallace, and Dossett, 1973). This literature shows how educational institutions adopt, implement, and finally institutionalize educational innovations.

Assumptions and Principles of Change

From the last 20 years of literature on the change process, Clark (1990) distilled several assumptions about change. Although these assumptions were applied to innovations in the classroom behavior of public school teachers, they appear relevant to teacher education as well. Below, in italics, are six of her assumptions that apply most directly to the use of multimedia followed by a brief comment on the application to teacher education.

1. *Experienced teachers seldom become committed to a new program or innovation until that have seen that the new practices work well in their classrooms with their students* (Guskey, 1986). This is particularly true in the university setting. Professors have duties in addition to their teaching. If their teaching has been successful in the past, there will be a tremendous resistance to change.
2. *New practices entailing a significant amount of change live or die by the amount of personal assistance teachers receive such as reassurance, support, expansion of users' repertoires, problem solving, helping users master the practice, and increased interdependence* (Guskey, 1986). Particularly in multimedia and especially for teacher educators, technical support is essential. Beyond technical support, teacher educators feel at risk in trying new ideas in class; failure is more threatening to them than any other teacher. They are supposed to be the experts.
3. *Forceful leadership is the factor that contributes most directly and surely to major, effective changes in classroom practice that become firmly incorporated into everyday routines.* (Crandall and Loucks, 1983). In public school settings, principals will occasionally accomplish change by fiat; they decree that it will be done the new way. Deans of education must deal with professors who have been compared to volunteers (Greenberg, 1993). That makes the individual investment of each professor much more important. Change by fiat is unlikely in most universities.
4. *Implementation is a necessary but not a sufficient step toward sustained improvement. Institutionalization should include writing the practice into the school curricula, into standard operating procedures and policies, into yearly materials and staffing cycles, and eliminating competing practices (Crandall and Loucks, 1983).*
5. *Practices in order to effect change, must be used on a large enough scale to alter entire patterns of learning and teaching* (Purkey and Smith, 1982). For teacher education, this assumption (as well as the previous one) means that multimedia must be written into program descriptions, and course syllabi, as well as daily lesson plans. It is not enough for isolated teachers to be exemplary. We must strive together to create common standards of excellence that include the development and use of multimedia.
6. *Assume that conflict and disagreement are not only inevitable, but fundamental to successful change. Any*

collective change attempt will necessarily involve conflict (Fullan, 1982). This assumption regarding change is probably more true at the university level than at the public school level. University professors are notorious in their independence; very few other professions have such flexibility in how they account for their time and so much control over their activities (Greenberg, 1993).

To distill Clark's assumptions regarding change even further, three principles emerge.

1. Change is slow
2. Change is individual
3. Systemic change requires a plan

Estimates regarding the time required to institutionalize innovations range from 18 months to 5 years. That change is individual means that systemic change occurs only as individuals change their practice. In some ways, the plan is what is missing in most institutions of higher education. At this point most of the plans seem to focus on supplying equipment. This is indeed a necessary prerequisite, however, equipment alone is not alone sufficient to insure change.

Factors that Inhibit Change

"To ask faculty to change a curriculum is like asking someone to move a graveyard. It can be done, but it is a funky, messy, complicated, long process" (Cole, cited in Bateson, 1989, p.98). The integration of multimedia into teacher education programs is bound to be difficult. Some of the major factors that inhibit that change follow.

Technical Issues. Technology changes almost daily. Weekly publications exist that cover the changes in the capabilities of technology. In a sense this dooms the educator (the teacher educator in particular) to failure in keeping up with the state of the art; as soon as equipment is purchased, software is learned, and successful integration into a teacher education program is accomplished, it is out of date. This creates an inevitable gap between what is possible and what is commonly used. As the rate of change in technology continues to increase, that gap will likely increase.

Rapid Rate of Change. If, as Falk and Carlson (1992) assert, it is the case that most teachers teach as they are taught, education is in sad state indeed. I started this piece comparing the information revolution to the industrial revolution. One of the obvious differences is the rate of change. The rate at which information doubles continues to decrease. Before long, it will be doubling every five years. Applied to teacher education, that means that as a profession, we will be learning as much about education in the next five years as we have learned since the beginning of recorded history! If the primary way of changing teaching behavior is through training new teachers, then that rate of change in that pursuit is being continually outstripped by the rate of change in the knowledge about teaching.

Money. Branscum (1992) observed that equipment is a necessary prerequisite to the integration of multimedia into teacher education. Estimates on developing computer labs range from $50,000 to over one million dollars. There not a strong indication that the moneys necessary for the integration of technology into teacher education will be made available. Colleges of education are caught in a double bind created by the rate of change in technology. On the one hand, they must utilize cutting edge technology if their students are going to be able to make use of current applications in their classroom practice. On the other hand, the newest equipment and software is expensive and colleges of education must spend heavily just to keep up.

Priorities. The fact is that teaching is not highly valued in many university settings. That "publish or perish" is a cliché shows the perception that publishing is more important than good teaching. As long as good teaching is not valued as much as research, professors have little incentive to change their current practice.

Factors that Enhance Change

Just as there are critical factors that discourage the incorporation of multimedia into the teacher education programs, there are key factors that encourage it. As educators become more sophisticated in their knowledge of what enhances educational change (Clark and Schumaker, 1991; Kline and Clark, in press; Kline, Deshler, and Schumaker, 1992), we can make specific applications to the incorporation of multimedia into teacher education. A discussion of four such factors follows.

The Power of Multimedia. The innovation itself is one of the most potent arguments for its inclusion in teacher education. Multimedia answers pressing problems in teacher education. For example, field experiences are key ingredients of most teacher education programs (Potthoff and Kline, in press), yet field experiences by their very nature are unpredictable. Education is such a varied enterprise that one cannot be assured of seeing the same thing twice—or once for that matter! If two preservice teachers are sent to the same teacher and the same class at the same time, even with fairly explicit instructions on what to observe, they will almost certainly report different things. Multimedia can remedy this problem by providing an observation of a classroom for an entire group of preservice teachers (Reilly, Hull, and Greenleaf, 1992).

Another possible application would be to explore student differences through the use of case studies. For example, common characteristics of learning disabilities (e.g. perseveration, long latency periods) could be shown on video and discussed, or could be placed in an activity in which students would be shown several video clips supported by text and encouraged to reflect on their observations.

Increasing Ease of Use of Technology. Multimedia is not a new idea. It was first proposed in 1945 by Vannevar Bush who was with the US Office of Scientific Research and Development during World War II. At that time the technology was not even available. In 1965, Ted Nelson conceived the idea of nonlinear links in text, and soon it was applied by NASA to link Apollo documents and by Stanford Research Institute to link computer files

(Wishnietsky, 1992). It wasn't until the late 1980's that the technological foundation required to link various media in nonlinear fashions became readily available. Wishnietsky (1992), noting the current extensive development of multimedia, expects it to be readily available in homes by the year 2000.

Earlier Experience with Technology. If a student has had earlier successful experiences with technology, he or she is more likely to use multimedia successfully (Gay, 1986). Actually, multimedia is merely the combination of media that are mostly familiar to teachers. Most faculty have in their experience, and use on a regular basis, video or motion pictures combined with sound and other elements of multimedia. The "strange part" is merely the combination of the elements and the computer driver. As integrated curriculums are becoming more popular and computers are becoming more common, it is likely that multimedia itself will become more familiar to faculty.

Faculty Support and Time to Practice. When teaching is set as a priority and appropriate resources are made available, faculty will begin to use multimedia in the development of their courses. As noted above the issue of support is critical especially for faculty in colleges of education. The support must include a genuine commitment by peers and administration to the improvement of teaching at the university level. This support is critical because as faculty experiment there will be inevitable failures, and teacher educators are supposed to be the experts. When they fail, they must feel supported by their peers and by their administration.

Increasing the Capacity for Change

Falk and Carlson (1992) have asserted that teachers teach the way they were taught. This may actually be the answer to the dilemma presented to education faculty by the information revolution. The rate of change in all areas is increasing. There is more and more for students to learn with no increase in the time to learn it. We cannot hope to keep pace with the rate of increase in information to teach. The implications for all of education and teacher education in particular are plain—students must focus on the process of learning rather than the products of learning. We have to teach our students how to learn rather than specific content; the content we teach may very well be out of date before it is applied. For teacher education, faculty must model in their own practice the acquisition of research-based innovations. If students do teach the way they are taught and are to grow into the flexible, innovative professionals required, they should be taught by faculty who continually try new ideas. As a necessary correlate to this, preservice teachers will be exposed to appropriate models of instructor failure. That is, they will see expert teachers try something new that doesn't work, change their plans, and recover from the failure. Exposure to faculty who are honestly grappling with their failings and who are honestly pursuing excellence, will be the strongest model of appropriate teaching possible. Right now, the inclusion of multimedia into teacher education programs provides the best opportunity to model the incorporation of a theory driven, research-based innovation into educational practice.

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Technology and Faculty Collaboration: Psychological and Sociological Factors and Effects

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What is it that prevents faculty members from using technology to enhance their instruction? In an insightful article by Johnson, Harlow, and Maddux (1993), a national survey conducted by Johnson (1992) is cited as an indicator of the extremely low incidence of the use of educational technology for innovative teaching. Johnson, Harlow, and Maddux also relate the concern of a student regarding the lack of integration of technology into instruction: "I keep hearing this [the need for technology in instruction], yet as I walk up and down the halls of the college of education, all I see is professors lecturing to students" (p.118).

In many cases the barrier to the use of technology in instruction is as straightforward as a lack of hardware or software, or a lack of administrative support of technology in the curriculum. But what about the situations in which there is no lack of hardware or software, where the integration of technology into the curriculum is a part of the stated mission of the school, where technology-experienced faculty are available and devoted to assisting with technology integration? The latter, technology-rich scenario is a description of the setting from which this pilot project emerged. The four individuals involved in this pilot project were committed to not only the integration of technology into the curriculum at our school, but also to closely examining the psychological and sociological factors and effects we experienced throughout planning, developing, implementing, and revising the courseware we built and employed in a summer school graduate class.

One purpose of this paper is to communicate our impressions and findings regarding the impact that coming together around the computer had on each of us as teachers, scholars, colleagues, and human beings. Another purpose is to examine the psychological and sociological factors and effects that must be addressed as faculty attempt to collaborate on integrating technology into their instruction.

Participants

Of 11 faculty members who had been asked to teach a graduate level Research and Statistics class during the summer session, four indicated an interest in working collaboratively to employ computer-based courseware. The individuals involved in this project included:

- the chairperson of the Department of Educational Technology, who is a heavy user of technology and is "on a mission" to get other faculty to use technology in instruction.
- an educational/cognitive psychologist who has a joint appointment to the Department of Administration, Curriculum, and Instruction, and the Department of Educational Technology, who is also committed to integrating technology into instruction, but who is less technically sophisticated than the chairperson.
- a faculty member who is highly experienced in educational administration, and is a member of the Department of Administration, Curriculum, and Instruction, who is very new to the practice of integrating technology into instruction, but has "got the technology bug" and is self-directed and motivated in this area.
- a principal of a large elementary school who adjuncts for

the university in the summer, who is also new to the integration of technology into instruction, but is enthusiastic and open to any and all vehicles to advance and promote learning.

Data Collection

Data for the project were collected throughout the three months of planning and developing, the month of the course, and is continuing in a post hoc reflective mode. The methods for data collection are naturalistic, participant observer, and qualitative. We found this to be most appropriate as the project is in a pilot phase and we sought to discover emerging themes from our experiences and conversations (Borg & Gall, 1989).

Results

The four faculty had a wide range of experiences and comfort levels in the area of educational technology and research and statistics. They devoted many hours to exploring and discussing the challenges involved in collaboration with technology. One of the major areas we soon became aware of was that of differing degrees of fear related to the technology on the part of three of the four participants. These fears were articulated and discussed. They included fear of looking foolish, fear of asking for help, fear of not "catching on" quickly enough, and fear of not being able to be effective with the technology in instructional settings. It was important for us to note that these fears were self-imposed and self-generated, but very real nonetheless.

These fears are consistent with the notion of anxiety and lack of confidence in learning to use computers as studied by Loyd and Gressard (1984) and Poage (1991). In both studies it was found that the presence of anxiety and a lack of confidence when attempting to learn to use the computer had a negative impact on learner progress. Aware of this, we worked to minimize anxiety and enhance confidence throughout the project.

Other challenges of a psychological or sociological (rather than technological) nature also included:

- the challenge of blending styles and modes of working of the participants, i.e., differing speeds of working, linear vs. non-linear work patterns, a focus on the theoretical aspects of the technology and the course content versus a more practical focus, and varying needs to converse about the work.
- a lack of practice on the part of all participants in true collaboration centered around instruction. Although all participants had collaborated on research or on projects of a non-instructional nature, none had experienced a true collaborative approach to planning, developing, designing, and implementing instruction.

Structure of Communication and Collaboration

With open recognition of and some degree of fascination with these psychological and sociological challenges, the participants in the study chose to process these psychological and sociological factors as a necessary foundation for true collaboration. We held regularly scheduled, two- to three-hour meetings for the three months prior to the start of the class. Our goal was to establish shared visions and expectations for course content, integration of the technology, evaluation of student learning, and design of the computer-based courseware.

Our meetings continued throughout the month in which the class was held. During these meetings, we invariably would discuss how unusual it was to be so open and communicative, and at times, critical of each other's instructional philosophies and practices. Even the most concrete issues such as time extensions for work not accomplished within the time of the course, and grading policies were discussed and agreed upon. Clearly, these issues were not the stated, central concerns of the collaborative effort. We had come together to work on integrating technology into our section of the Research and Statistics course. Although our discussions usually began with a focus on courseware content or design, they often expanded to include reflection on our current and past instructional practices, our increasing comfort levels with the integration of technology, and our increasing skills in true collaboration and the enhanced collegiality that resulted.

Conclusion

A new challenge faces us as we attempt to achieve infusion of technology into instruction. We must acknowledge and embrace the very human risks that are inherent in stepping toward technology as a powerful vehicle for "maximizing the chances that learning will occur" (Glover & Bruning, 1990). The risks are real for all of us, not just the novices in the area of educational technology. Highly experienced users of educational technology must also take risks as they attempt to work with and support those who are new to this venture.

In our pilot project this past summer, we all risked, and we all won. We learned a lot about educational technology and research and statistics, but we learned the most about communication, collegiality, and collaboration. In our experience, contrary to many informal comments often heard about the dehumanizing evils of technology—that computers detract from the building of a human connection between colleagues and between teachers and learners—we found just the opposite. We found the technology to have a profoundly humanizing impact on the whole Research and Statistics teaching experience. It bound us together around a set of common struggles and triumphs. We believe the technology was a critical catalyst in bringing us together in such powerful and positive ways and we are looking forward to continuing our project next summer.

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Connective Skills: The Gap Between Information Technology and Reality

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A decade ago, technologically light-years in the past, John Naisbitt (1982) warned that the United States was in a major shift, from an industrial to an information society. In an interview with Naisbitt, Charlotte Cox (1983) asked questions that are still pertinent today. Naisbitt explained that technology could manage this new information society, but only to the extent that people were skilled in its use. Non-menial jobs in this society are related to information processing, utilizing equipment ranging from linear software to voice-activated laser disc technology.

Naisbitt strongly believed that schools must focus on teaching students how to learn in a life-long commitment to learning. To Naisbitt, our society requires learners who are flexible and can apply well-grounded problem solving skills in order to adapt to changing situations. He suggested that "Schools should reevaluate whether they're in the business of loading students up with information or teaching them how to learn" (Cox, 1983, p. 8). To prepare learners who are technologically marketable, schools must recognize that as people gain experience in the use of technology, there is a greater focus on interaction with others, in problem solving situations, in critical thinking activities, and in knowing more about activities that will open new vistas for advancement.

Howard Gardner's research on multiple intelligences also suggests a need to move from a focus on the development of basic skills to educating students to apply concepts, principles, and skills in any situation, particularly a new setting (Gardner, 1993). Gardner believes that less is more and that learners have a greater possibility of understanding if concepts are taught at a deeper level. The use of information technologies can be key to enabling students to develop and demonstrate proficiency in critical thinking.

Introducing Technology into Schools

Some educators assume that effective use of technology and current educational structures and practices are incompatible (Newman, 1992). In many schools teachers are virtually illiterate as to the most basic functions of a user-friendly computer. Yet other schools have enthusiastically adopted advanced technologies such as CD-Rom and laserdiscs, local area networks, integrated learning systems, and teleconferencing.

Teachers may be expected to respond to technological innovations in a number of ways. Examples of responses which raise concern include:

1) Immediate acquiescence: when teachers demonstrate absolute trust in the "experts" and are willing to accept any type of information technology, whether valid and reliable or not.
2) Apathy: when teachers accept information technology without questioning either system or product.
3) Reluctant acceptance: teachers who accept information technology of any type because they fear what may happen if they fail to change.

4) Avoidance: teachers who avoid accepting changes involving information technology because of either fear or anxiety.
5) Reactionist rejection: when teachers oppose a particular form of information technology, regardless of the consequences.

The preferred response is for teachers to readily accept and use new forms of information technology because of personal understanding, awareness, logic, and common sense.

To determine if and how technology can be effectively used in schools we must consider a number of questions:

- How can teachers present the exploding morass of information in a meaningful way?
- Are teachers prepared to critically select the appropriate hardware and software needed to facilitate the transfer of information from technology to student?
- How can teachers prepare students who are technologically literate and marketable in a high-tech business and industrial environment?

Required Connective Skills

Connective skills enable one to interface two or more elements with minimal effort and maximum quality. Teachers' abilities to "connect" the cybernetic world of computers with the reality of life in classrooms are key for maximizing information technology in the classroom. Specifically, teachers must:

A) protect students from information overload, which refers to a student's inability to think clearly as a result from excessive cognitive stimulation;
B) recognize and seize the advantage of technological innovations and understand how they may be used to enhance learning;
C) safeguard themselves against a dependence on any technology system or device they do not fully understand or control;
D) thwart the seductiveness of information technology which appears to offer a "quick fix" but is not based upon valid instructional principles; and
E) learn to accept and adapt to changes inherent in the fields of education and technological development.

Schools preparing students for the twenty-first century are under pressure to provide graduates who can remain technologically literate in the most advanced innovations. Administrators are faced with acquiring expensive equipment, matching the technological advances with the prescribed curriculum, finding educators with the requisite experience, and encouraging experienced educators to learn new innovations which are often threatening to seasoned teachers (Armstrong, Henson, Savage, 1993).

The connective skills which teachers today and tomorrow will need are those skills which will allow learners and teacher/facilitators to probe more deeply into the explosion of information, thereby keeping current with the needs of modern society.

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Infusion Through Transfusion: Interdisciplinary Cohorts, Time and Multimedia

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The Center for Excellence in Education (CEE) has the potential for being an instructional technology support for not only CEE faculty, but for faculty from all colleges at Northern Arizona University (NAU). A teaching lab for students already exists at CEE: we have a facility which houses 21 Macintosh LC's with Apple IIe cards and drives, extended internal memory (10 MB), 9 CD-ROM drives, 6 mobile teaching stations, and wide range of software for the Apple IIe and Macintosh. Each of six teaching stations consists of a mobile cart which supports a computer (Apple IIe, Apple IIGS, Mac SE, Mac LCII, Quadra, IBM), an overhead projector, and an LCD projection panel. In addition, a student/faculty Multimedia Development Lab was recently created with a Mac Quadra, text and graphics scanner, laser disc player and monitor, camcorder, still-video camera, bar code reader, musical keyboard, and assorted laser and CD-ROM discs.

The Multimedia Development Lab has been used minimally by both CEE students and faculty. A goal for CEE is that all students will be able to use the multimedia equipment for curriculum integration before student teaching. Students must see multimedia and other instructional applications integrated into their courses, however, to understand the application to instruction. Teaching faculty must themselves learn new methods and new applications of technology before they can act as facilitators to student learning in this area.

Many faculty have expressed a concern that it is difficult to assign student technology projects when they themselves don't know what the equipment can do. Most faculty, however, *do not have time* to learn new technologies with full-time teaching loads, growing class sizes, and research and service obligations. A faculty multimedia cohort group was formed last year, but lack of time and teaching obligations prevented the group from going beyond "show and tell" sessions.

CEE's Technology Committee decided to help faculty with the time factor. One of the main charges for this committee is to help integrate instructional technology into teaching. The Technology Committee, through a university funded technology grant, has introduced a staff development component for CEE and for NAU faculty in instructional technology for the 1993-94 academic year. Included in this plan are components which have been recommended for successful technology integration: commitment to new technology and change, long-term technology consultant support, demonstrations and modeling, goal setting and resetting, peer group support and collaboration, individualized instruction, recognition and reaffirmation of beliefs, and time (Moursund, 1989; Gunn, 1990).

Participants

Seven CEE faculty members from different disciplines in the College of Education each with 1/4 release time for AY 1993-94, will use a staff development model developed by the CEE Technology Committee for technology infusion into undergraduate and graduate courses. This staff development model, using a trainer-of trainers component with load release time (transfusion), will be evaluated by one participant through an evaluation and tracking model for innovation in technology. Several faculty participants are keeping reflective journals of their process, and students in specific classes are also keeping journals.

Transfusion: Fall 1993

Participants are learning a particular application of a portion of multimedia (i.e., using video camera connected to computer, video editing, developing electronic interactive course modules) and are teaching other participants that application. During the fall semester, participants are applying that technology knowledge by developing applications for their particular area and are demonstrating to their colleagues the direct application to classroom instruction. These efforts are supported by faculty release time—a transfusion of time and/or money.

Infusion: Spring 1994

Four seminars are planned for the spring 1994 semester, three of which include multimedia demonstrations, sessions on instructional design, and individual and group goal setting with CEE faculty. The fourth seminar will be open to faculty from all colleges on campus. These seminars require 1/4 release time for the same participants to plan, develop, and teach the seminars. Between seminar sessions, the participants will be involved in individualized instruction and consulting for CEE faculty. Outside funding will be sought to continue this staff development plan, to add new technology to the Development Lab, and to provide NAU faculty with staff support. It is planned that a second year will allow expansion for instructional seminars for interested NAU faculty. The staff development participants will also write working papers of their process and evaluation of the staff development model.

Staff Development Activities

Workshops

Participants in this technology grant have attended mini-workshops on specific hardware and software available in the Development Lab presented by the Coordinator of Instructional Technology, a grant participant.

Participant to Specific Areas

The Educational Psychology participant has been working with *HyperCard* to design and give interactive tests or review questions to students. This fall semester has been spent in streamlining tests for students with a variety of test question formats and with feedback provided to student responses. He has tested it with students and introduced the educational psychology faculty to the concept through demonstration.

A larger campus-wide introductory seminar was held for all interested faculty at NAU by the Coordinator of Instructional Technology. This seminar consisted of demonstration and discussion of CD-ROM, interactive laserdisc, still camera, and video, as well as applications to the university classroom. The seminar was sponsored by NAU's Office of Professional Development and Wakonse Teaching Fellows as a first-step in orienting faculty unfamiliar with terms and equipment and to provide a vision for instructional technology in their own professional development plans.

Individual Efforts

Our multicultural/bilingual participant is becoming familiar with interactive video-to-computer production and is developing classroom applications. With his background in film and television, he is providing a much-needed support for grant participants and CEE faculty to learn this multimedia application and its infusion into the university classroom. Small group workshops are planned for the end of the semester with grant participants.

The Coordinator of Instructional Technology has offered seminars for CEE faculty and staff in the operation of still camera and the graphics and text scanner, as well as application to the university classroom. Small group workshops have been conducted for students in nine lab sections of an educational technology course, and to a designated group of students in a secondary methods course.

Several participants, new to technology in general, have made use of this grant process to investigate technology support in their particular area: elementary, secondary, and special education. They have spent several orientation sessions with Technology Lab staff in familiarizing themselves with software available in their areas and have attended orientation sessions provided by other participants to become familiar with emerging technologies. One participant, a beginner in technology applications, is becoming familiar with CD-ROM and is using commercial clip art in classroom handouts. A second participant, also new to most technology applications, is becoming familiar with qualitative research software as she evaluates student journals in a rural special education grant. The third participant, while orienting herself in the technologies available, wanted a faster way for her students to see technology integration. She has established student technology "expert" groups using a student "Trainer-of-Trainers" model.

Student "Trainer-of-Trainers"

A student "trainer-of-trainers" model was developed and implemented to expedite the infusion process. In the past, the secondary faculty participant relied on the Coordinator to give a 50-minute presentation to introduce secondary education students to instructional technology in a curriculum development course. It is difficult to use this type of one-shot presentation in this particular course, as students are from different content areas, all diverse and non overlapping (i.e., music, English, Chemistry, Spanish). To model technology integration with all available equipment in all secondary areas represented requires a bit more than 50 minutes!

We therefore adapted an often-effective faculty development plan used in a number of educational settings to this secondary curriculum course. Students work in cooperative groups by content areas throughout a major portion of the course to develop a curriculum of the future. In the past, students in this course have been required to preview and evaluate a non-print source to be included in the group curriculum plan. Students have also been required to include technology in the plan, but other than guidance from self-selected articles, there had been no other required exposure to technology.

At the beginning of the grant-supported fall semester, students in each group volunteered as the technology "expert" for their content area. Each technology expert met with the Coordinator of Instructional Technology for a 50-minute presentation—similar to the whole class introduction from previous years, but with only the "experts" in attendance. Each small group from individual areas met for specific training in applications from their content areas. Before curriculum plans are finished, the whole group of technology experts will present their findings and expertise to the class through demonstration. An added benefit of this model is that each content group has one or more experts who have not only learned about emerging technologies with hands-on opportunities, but they have also worked with the Coordinator of Instructional Technology on how those technologies might be integrated into their content area. It is anticipated that the final curriculum plans developed by content groups will show true integration of technology, rather than haphazard technology add-ons.

Evaluation

The Educational Leadership participant attended a training session on a "Levels of Use" (LOU) evaluation and tracking model for analyzing innovation in technology over long periods of time. This model describes the various behaviors of the participants as they pass through different stages—from spending efforts in technology orientation, to managing, and finally to integrating multimedia technology. There are several levels of use that participants will surely encounter while becoming more proficient and this model will track these stages and will allow the participants and CEE to know on what level the user is operating.

The behaviors that a user exhibits are organized in the form of characteristics at each level. Interviews are administered to participants to assess level of use on a monthly or yearly basis. A framework of indices and decision point guidelines have been developed so that CEE's project participants' progress can be monitored. This framework will allow the evaluator to chart the level each participant is operating at as we become more knowledgeable about multimedia and its infusion into the classroom. A levels of use chart will be produced by CEE's evaluator so our development process can be understood and measured validly and reliably. It is through a series of interviews with the participants and the subsequent charting of the levels of use that our evaluator will be able to obtain a personal and institutional view of whether or not multimedia has been integrated into our teaching, and eventually, into the life of the CEE. The value of LOU as both a formative and a summative evaluation tool is that participants can understand and monitor their own use of the innovation and can gauge where they stand in relation to participants and to CEE as a whole.

Release Time: Transfusion or a Bleeding Wound?

Finally, an opportunity for much-needed release was made available. Though members of the committee were sure that this would provide "the answer," this component of the grant has not provided the relief that was expected. CEE has experienced tremendous growth in the past three years, but without adequate funding to support the numbers of students enrolling in our teacher education program. Most faculty loads are at 12 teaching hours and a few faculty are teaching an overload (i.e. five classes per semester).

Of seven participants, only *one* was able to arrange 1/4 release time; the other six are participating with an overload. One explanation of this failure to comply to the release time seems evident: CEE's administration provided a 50-50 match to the grant by providing money for release time ($500/one-credit hour), but did not support faculty in making that happen. Each participant is in a somewhat specialized area where part-time adjunct faculty may not have been available to cover the load. There is, however, money compensation by including the technology grant as a paid overload, which might be viewed as moving in the right direction. Evaluation of this staff development plan will include interviews with participants as to their perceptions of release time versus paid overload, and hopefully the energy and time required beyond a typical load will be documented for further study and reporting to CEE and NAU administration.

Participants: Infusion or Confusion?

The infusion is slow to take place. It was assumed at the beginning of this grant funding period that seven participants learning to use individual technologies could learn about and provide adequate instruction for the rest of the participants to be ready for spring classroom integration. As the first semester draws to a close, most participants are still struggling with their own instruction and classroom integration is not as close as we had hoped. Would *real* release time rather than overloads have accomplished this infusion process successfully? Hopefully, we will get a second chance to test the assumption that actual release time would provide opportunities for development and practice of classroom technology infusion.

The Success Story

Seven faculty members of CEE are further ahead in the area of instructional technology than they were last year. Students request use of the CEE Multimedia Development Lab in enough numbers that we are not able to keep up with individualized instruction. The Instructional Technology Coordinator is developing student seminars to introduce students to emerging technology in small steps, but in larger groups. Faculty as a whole are asking questions about the newest technology available in the Development Lab. Equipment and software are often checked out for weekends and holidays, or mobile stations are wheeled to faculty offices occasionally. Checkout of the Mac multimedia demonstration carts has increased to the point that we are evaluating our checkout procedure. Several participants, who admit that the extent of their technology use was using a word processor before the project, are now attending seminars, asking questions, and can include some form of technology development into their individual growth plan. It was the grant writers' expectations that release time was a critical component for technology infusion, and while we must pursue this further, seven faculty members out of 65 are getting paid extra to spend time learning emerging technologies.

Another advantage of this grant participation is that participants are working as a team. We keep in touch via e-mail and share our progress and process frequently through electronic meetings. The cadre formed by the grant has created a team that has a variety of interests and backgrounds that lend themselves to a comprehensive work group (i.e., a former TV and film producer, a person interested in evaluation of technology innovations over time, a psychologist looking at learning and technology).

Little Steps

As in most things we tend to do at CEE and in education in general, it seems, our vision was grand and we are now adapting to real life. There still is not enough time available to learn emerging technologies as we would like. But looking back over this first semester, the little gains stand out.

Technology-expert students in a secondary methods class will leave their course with an in-depth look at technology to support their individual content areas, while their peers have been exposed to technology through demonstration. All will have completed a curriculum of the future which includes technology as a *support* and *in their content areas*.

The Multimedia Development Lab has outgrown its space—the small space allotted to this project can not hold all the students and faculty interested in instructional technology or multimedia development. The checkout of specific equipment, such as the still camera, has caused waiting time for students who also want to check the camera out for class projects. Many students are asking for support in getting equipment into classrooms for demonstrations and projects; they are excited as they bring technology into some classes for the first time and expose faculty and peers to the potential of instruction supported by technology. A number of education faculty must reorganize their schedules and syllabi as the technology demonstration carts are reserved ahead of class times; no longer can they expect to use technology on the spur-of-the moment. The quiet, hidden-away spot used by only a few is now a hot spot in CEE.

Summary and Reflection

Several participants have submitted an interdisciplinary panel to a world conference on multimedia to present our project. Two participants have submitted an NAU Organized Research grant proposal for summer funding to edit working papers which all participants have agreed to write as part of the staff development project. This Organized Research proposal also includes support for soliciting working papers from leaders in the field of instructional technology for an edited book, and to seek outside funding for the development of a Center for Research in Instructional Technology.

CEE continues to provide outstanding support for technology infusion in our teacher education program, through money to support the purchase of hardware and software, and also in the support of people by buying time. The Coordinator of Instructional Technology position is a 1/2 load assignment which includes faculty development in the area of instructional technology. CEE administration supported this faculty development grant by providing a 50-50 match with money designated for "transfusing" faculty with release time. Technology is accessible and interested faculty appear ready to begin or step up the technology infusion process. We are excited about the successes already evident from this staff-development model and the evaluation procedures in place. Now it is a matter of time...or is it?

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An Approach to Technology Integration for Reading/Language Arts Teacher Education Faculty

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Many teacher education institutions have identified the need to integrate the use of technology within their teacher preparation programs. Soloman (1992) suggests that new teachers must understand the potential of technology and how technology can help to restructure the learning environment. In order to develop this vision, preservice teachers must have educational experiences throughout their preparation program that model how computer-related technologies can be used for instruction and as learning tools (Byrum & Cashman, 1993). Therefore, technology integration has become a critical issue facing preservice teacher educators.

One desirable goal for many teacher education programs is for technology to become a natural part of the teaching and learning environment for all faculty (Bruder, 1989; Nelson, Andri, & Keefe, 1991). According to Handler and Marshall (1992) all faculty should assume the responsibility of modeling appropriate uses of technology as an instructional tool for students. Technology must be introduced to faculty members in such a way that they see a purpose and a use for technology in their content area (Stephen & Ryan, 1992). When the computer becomes a necessary tool for the faculty member, then the use in the classroom in the next logical step (Johnson & Harlow, 1993).

During the 1991-1992 academic year, a three-year technology integration plan began in the Department of Curriculum and Instruction at Iowa State University. The major goals of this three-year plan are to provide computers and networking for faculty, to provide voluntary workshops for faculty, to provide support for answering faculty questions, and to provide support and models for classroom integration. The plan has continually been updated to meet the needs of the faculty. This paper describes the mentoring approach that was used to assist faculty members in using technology in their courses during the second year of the technology integration plan and the results of the approach.

Year Two of the Integration Model

Year two of the technology integration plan (1992/1993) called for the beginning use of computer-related technologies in education courses by interested faculty members. In order for this to occur, faculty needed access to facilities that were equipped with computer technology. During the first year of the plan two classrooms were equipped with computers and related technologies for whole-class instruction and participation. Portable carts that include computers, CD ROM drives, videodisk players and color LCD panels were available for faculty and student checkout. Over 1,000 pieces of software are available in the computer lab for instructional use.

During year two, a major focus was to assist faculty members with the integration of technology into their course(s). Interested faculty were given technology support by other faculty, faculty members, teaching assistants and students. In order to meet the needs of some faculty, a mentoring program was established that teamed an instructional technology faculty member with faculty members.

The Mentoring Program: The Process

Two of the reading/language arts faculty members expressed interest in integrating technology into their content courses. It was decided that a mentoring group would be formed that included the two reading faculty members and an instructional technology faculty member. It should be noted that part of the technology faculty member's teaching responsibilities was to work with faculty interested in using technology. Clearly, there is administrative support for the mentoring program within the department and college.

Throughout one semester, the group met weekly for an hour to discuss curriculum issues and to introduce various pieces of hardware and software. Additional time was spent by each faculty member learning and using software and hardware on their own, followed by group review of the application effort. Instructional emphasis was placed on integrating technology as a means of delivering the reading and language arts curriculum. This mentoring group maintained a focus on using technology which students could utilize for multiple purposes during and beyond their preservice teacher preparation as well as in the classroom with children.

The two reading faculty members involved in this group had little or no computer experience prior to this mentoring program. Until two years ago, neither faculty member had access to instructional technology in their office and technology in classrooms was limited to overhead, film, slide, and video projectors. In the Fall of 1991, both faculty members were given a Macintosh Plus computer for their office, later upgraded to a Macintosh LCIII. These faculty members now have access in their office to on-line communication systems such as the Internet, Scholar and the university gopher system. While attending national, regional and state reading professional meetings, both professors have expressed a new knowledge of the technology used and have shared their technology experiences with others attending these meetings.

The faculty members involved in this program used the mentor differently to integrate technology into their courses. One faculty member used the mentor as a resource to learn of software programs and to discuss possible classroom activities that integrate technology into the content area. In addition to learning and discussing possible uses of technology for instruction, the other faculty member also team taught with the mentor in various classroom situations. During classroom demonstration and discussion, the mentor modeled the use of technology while the reading faculty member helped facilitate student discussion. Although both faculty members approached the use of technology in their classrooms differently, each gained a new understanding of its impact in various curriculum activities.

In the sections that follow, each summarize their technology integration for instruction and learning. Again, the common goal for both faculty members was to integrate the technology in order to expand and enhance the content of their courses.

Instructor One: Ideas for Technology Integration Into Reading/Language Arts Courses

One target class was Reading and Writing Across the Curriculum, an elective, senior-level course with twenty-four students enrolled. Two of the students had completed student teaching, and the remaining students would student teach the following semester. Various levels of computer experience existed. Six of the students had completed one computer course; one student had completed three computer courses, and the remaining students had no formal computer training but had experience with the computer for various projects in previous classes. Seven of the students had a personal computer available at their residence. For this particular course, students were required to have a disc to devote to the class and were assigned to a three-person base-group depending on their level of computer experience. In each base-group there was at least one student who had completed a computer course.

The decision was made to concentrate on integrating a few, selected programs, using the software for different curricular purposes when appropriate: 1) teaching support and modeling; 2) student use as a vehicle to reinforce understanding of key concepts by engaging in course-related computer application activities; 3) follow-up application with children during field experiences. Follow-up application was possible for twelve of the students who were each concurrently tutoring a child in reading for another College of Education class.

During the semester I modeled software in class using a laptop computer and color LCD panel. Those class meetings featuring a lecture format were organized using a presentation software program called PowerPoint. Members of the mentoring group even started using the program for reports to the faculty during departmental meetings. The ease of use, the versatility, and the audience impact all generated a great deal of interest among colleagues.

I used a spreadsheet for collecting and reporting grades, and for conveying to students the organization for compiling a required notebook examples of the teaching strategies studied during the semester. During the course a modified spreadsheet was used as the framework for a review of the course content. During a follow-up discussion of the applications and the software, students were encouraged to consider other classroom uses.

I also demonstrated use of FileMaker Pro for organizing a department collection of alphabet books as a resource for learning in content areas. During the course discussions on the affective dimensions associated with reading and writing across the curriculum, students were given the task of searching professional journals to gather three reading/writing ideas with classroom application to one or more content areas which would be motivating for reluctant readers/writers. Each student was to enter the gathered ideas into a class collection by completing FileMaker Pro templates (see Figure 1). During the my office hours, students added to a class collection by reviewing previously entered

journal: Instructor Sept. 1992 Vol. 102 no. 2 pp. 67-68
author: Wilson, Linda
title: A Primary Project on Teddy Bears that Comforts Kids and Connects the Curriculum

summary: A great way to motivate children is by using literature and incorporating other aspects of the curriculum. By doing a unit on bears, (look at the bibliography lists of books) the teacher can teach science by having the children look at non-fiction books about bears. In math, they can classify the different types of bears, and estimate how many pictures of bears are in each book. In Social Studies, the children can learn about how President Theodore Roosevelt saved a bear and about the Smithsonian Institute. The teacher can have the students draw the different types of bears and then put them in order of size and weight of the bears.

subject area: Language Arts, Math, Social Studies
grade level: K-3
name: Sue Gase

Figure 1. Sample record from class collection of alphabet books and ideas using FileMaker Pro.

records to avoid duplication, and using the faculty member-designed template to enter each of their three ideas onto a record. For a follow-up computer lab, the collection contents were copied onto lab machine hard drives. During the lab, I demonstrated the sorting feature of FileMaker Pro. Students sorted the collection to find their own entries, to browse through colleagues' contributions and to find entries that could apply to a thematic unit they were preparing. Students printed at least two of the entries from the collection, and were encouraged to copy the collection onto their own disk for later additions and classroom use.

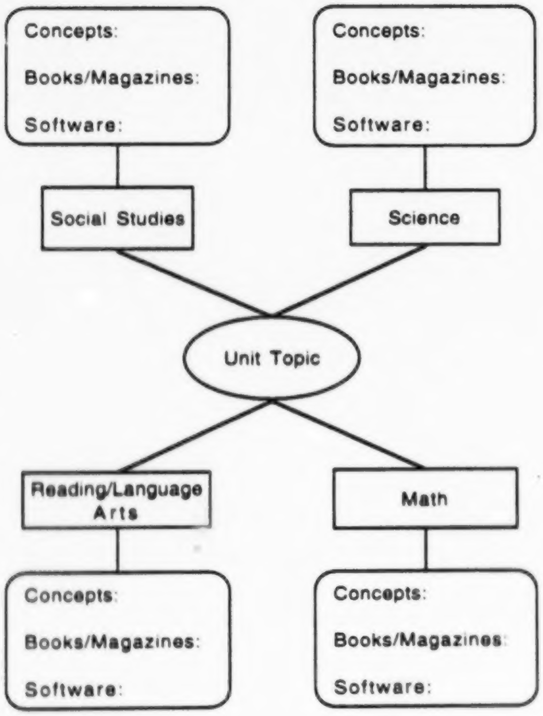

Figure 2. Sample template for the thematic unit content summary using Inspiration.

Another versatile tool software program used was Inspiration. This program allows the user to develop concept maps and outlines that help organize information and develop writing skills. In a modeling framework, I used the program to generate visuals to explain course content as well as to suggest applications of the software for use in the elementary classroom. Following class demonstrations, the base-groups practiced using Inspiration during a computer lab to review the course content as well as to become familiar with various features of the software. After this supervised practice base groups used Inspiration to summarize the contents of a thematic, cross-curricular unit they prepared (see Figure 2). Various features of the program had to be included such as color, various fonts and styles, display features and note function. Use of the program generated student discussion on how the software could be used in an elementary classroom.

An early emphasis was placed on the information handling and communication power of computers. Prior to the mentoring group, I had not been registered for e-mail. After a mentoring session on registering, accessing for sending and receiving mail, integration into the coursework was planned. Using step-by-step direction sheets, each student was required to register for an e-mail address, and reminded to check their mail weekly for course information and reminders. At the start of the class only three of the students had an e-mail address and only one of the students was a regular e-mail user. Although students were able to access e-mail in the College of Education computer labs as well as the library, the computation center and campus dormitories, care was taken to ensure that this was not the sole avenue for information. A large commuter population in the class made that an unfair avenue if students did not have ready access to a computer terminal.

In addition to receiving course reminders via e-mail, students in the class were assigned a class "journal pal" in a reading course at another university. They were required to

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use e-mail four times during the semester to communicate with that "pal" in order to summarize course content as well as to convey teaching tips they encountered during their professional reading. A copy of the journal entries forwarded to the faculty member allowed verification of e-mail use as well as the opportunity to monitor problems which students were experiencing with course content.

Student response to using e-mail was overwhelmingly positive. They discovered additional information handling and communication possibilities and shared with colleagues' shortcuts and available bulletin boards.

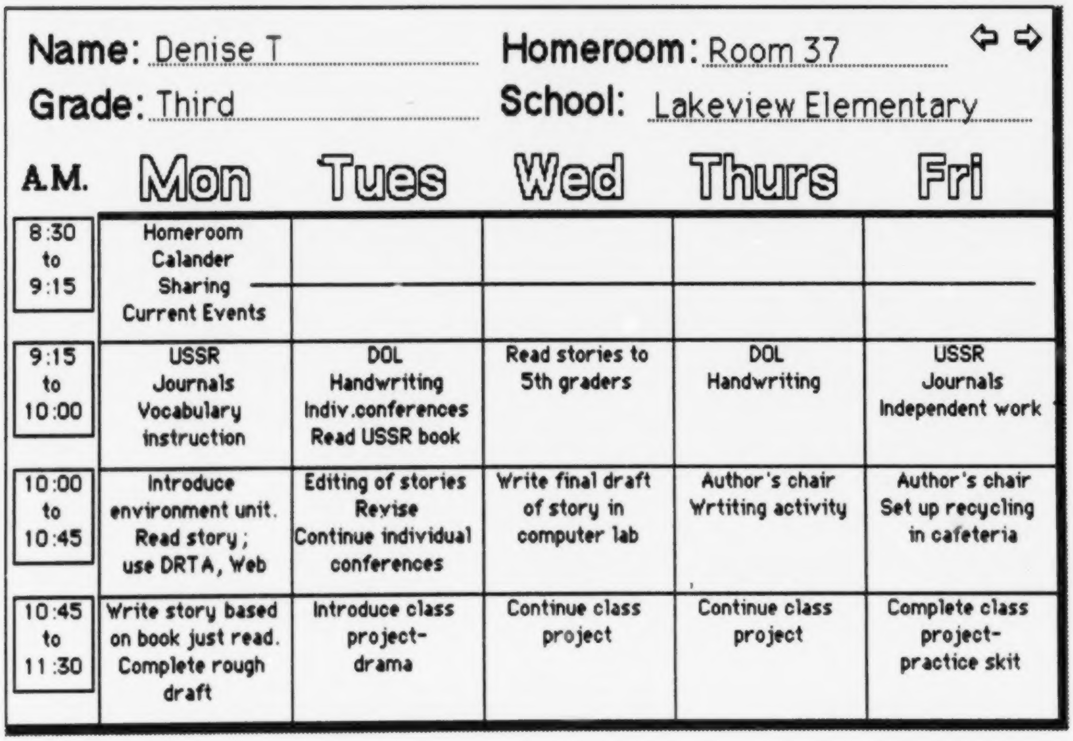
Instructor Two: Ideas for Technology Integration into Reading/Language Arts Courses

Incorporating computer technology into three courses was one of my major teaching goals during the 1992-1993 school year. Two of the classes targeted for technology integration were undergraduate methods courses and one of the classes was a graduate class in correcting reading difficulties. Less than half of the undergraduate class had experience using a computer while the majority of graduate students had some computer experience. By attending one of the departmental workshops on presentation software, I learned how to use the PowerPoint presentation program. Since the workshop, I have developed various presentations using this software program to use during class lectures.

The two undergraduate classes concerned the teaching of whole language in the curriculum. One of the basic ways that computers are used in a whole language classroom is for word processing. Each student was required to write their autobiography using a word processing program. Preceding this assignment students developed a time line of the events in their life. During one of the classes, a demonstration was given by the technology faculty member on how to use a software program called Timeliner. After the demonstration each student listed important events in their life and designed a timeline that included those events. A printout of the autobiographical timeline became a cover page for this assignment.

When demonstrating the Language Experience Approach, I used a portable computer teaching station. As a class member typed student ideas using a word processor, the story was displayed for the entire class to see using the LCD panel. After the class had completed the story and discussed possible classroom applications, students had the opportunity to copy and to print the story for future use.

Inspiration was another software program that I demonstrated to the students enrolled in the reading methods class. Using this software program the students were to develop a schematic map for a required thematic unit project.



Name: Denise T
Homeroom: Room 37
Grade: Third
School: Lakeview Elementary

A.M.	Mon	Tues	Wed	Thurs	Fri
8:30 to 9:15	Homeroom Calander Sharing Current Events				
9:15 to 10:00	USSR Journals Vocabulary instruction	DOL Handwriting Indiv.conferences Read USSR book	Read stories to 5th graders	DOL Handwriting	USSR Journals Independent work
10:00 to 10:45	Introduce environment unit. Read story ; use DRTA, Web	Editing of stories Revise Continue individual conferences	Write final draft of story in computer lab	Author's chair Wrtiting activity	Author's chair Set up recycling in cafeteria
10:45 to 11:30	Write story based on book just read. Complete rough draft	Introduce class project-drama	Continue class project	Continue class project	Complete class project-practice skit

Figure 3. Sample of a weekly schedule of morning activities for a whole language classroom using HyperCard.

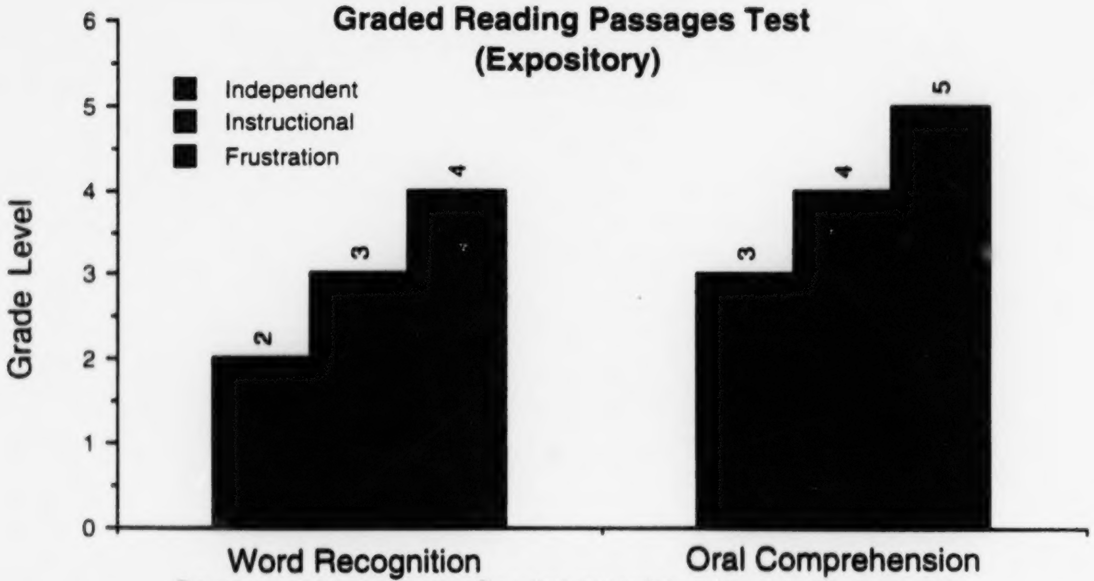


Figure 4. Sample Informal Reading Inventory using graphing program.

The students used the schematic web to organize their ideas for the unit and then used it as the cover page for their units.

Another required assignment for students involved planning an ideal whole language classroom with a weekly schedule of activities. HyperCard was used by the students to develop the schedule of activities for this assignment (see Figure 3). After a HyperCard demonstration by the technology faculty member, the students were given time to use the software and enter information into a practice template. Then, students entered their weekly schedule information into a template that was designed specifically for the assignment. In addition, students used a word processing program to explain the schedule and give justifications for the activities they had listed.

Technology was integrated into a graduate level course in correcting reading difficulties using a graphing program to document student test results. This graduate class involved the administration of tests to children by the inservice teachers that were enrolled in the course. Individual direction sheets and graph templates for each test were designed for this activity so students could work on the assignment independently. After inputting the children's test results into the graphing program, the test results were then printed in a bar graph form. The inservice teachers included the graphs in a case study report that was a requirement for the class. The graphs included the independent, instructional and frustrational level of the students that the teacher had tested with an Informal Reading Inventory (see Figure 4).

Conclusion

The mentoring described produced a variety of benefits. Faculty had the opportunity to collaborate on self-selected curriculum endeavors consisting of careful review of course content and analysis of opportunities for technology integration. The total experience was one of professional growth for those involved for the process was a valuable as the product. Faculty experienced targeted course content in a new dimension as well as anticipating adaptation of the technology to other courses they were teaching. Both faculty members grew in confidence concerning technology and became enthusiastic in their willingness to share their emerging skills with colleagues. It is important to note that the members monitored each to remain continually mindful that the technology was a tool. Often software was rejected or the implementation scope was modified due to time constraints or rejected if the use was deemed counterproductive to course outcomes.

Although the two faculty members became somewhat adept at troubleshooting problems they encountered, some problems still occurred during class that were difficult for them to address on their own. Both professors were reminded that anything can and will happen when using technology and have grown to be more flexible when these situations arise.

As might be expected, other difficulties remained throughout the semester. Both classes had more students enrolled than the computer lab could comfortably accommodate. Sharing was necessary but not desirable and compounded the already significant time constraints. The college computer labs were not always available, so spontaneous use of programs was not an option. Off campus courses posed other difficulties. Many of the off campus sites for graduate courses are not equipped with compatible hardware and software for student access. The faculty had to accommodate significant variability among students' computer experience and attitude. The base-group composition addressed this to some extent, but faculty had to continually monitor pacing, explanation and feedback when implementing and requiring program use. These difficulties are minor in comparison to the benefits that have resulted.

Preparing preservice teachers to use computer-related technologies throughout their professional careers is clearly a goal at Iowa State University. During the 1992-1993 school year, faculty were encouraged to collaboratively work at integrating technology in their content courses. Mentoring groups were formed that worked together to help and support their use of various computer-related technologies.

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The Nineties Teacher Locked Into the Seventies Classroom

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In a recent episode of the cartoon, *Calvin and Hobbs*, the precocious Calvin laments, "I am a twentieth century child locked into a nineteenth century family." His plight is echoed by many students of the nineties whose professors are locked into the classroom pedagogy of the seventies. This anachronistic situation was reflected in the results of a needs assessment conducted by the Technology Committee of the College of Education of Clarion University: the professional staff of the College knew basic fundamentals of word processing but little else about how technological applications such as spreadsheets, databases, interactive video, desktop publishing, CD-ROM, and HyperCard could facilitate and enhance their professional performance.

Recently, the International Society for Technology in Education (ISTE) submitted to the National Council for Accreditation of Teacher Education (NCATE) its recommendations for a set of national accreditation standards for educational technology. According to ISTE all teachers should be able to:

(a) evaluate and use computers and other related technologies to support the educational process;
(b) apply current instructional principles, research, and appropriate assessment practices to the use of computers and related technologies;
(c) explore, evaluate, and use computer technology-based materials;
(d) demonstrate knowledge of uses of computers for problem solving, data collection, information management, communications, presentations, and decision making;
(d) design and develop student learning activities that integrate computing and technology for a variety of student grouping strategies and for diverse student populations;
(e) evaluate, select, and integrate computer technology-based instruction in the curriculum of one's subject area(s) and or grade level(s);
(f) demonstrate knowledge of multimedia, hypermedia, and telecommunications activities to support instruction;
(g) demonstrate skill in using productivity tools for professional and personal use, including word processing, database, spreadsheet, and print/graphic utilities;
(h) use computer-based technologies to access information to enhance personal and professional productivity;
(i) identify resources for staying current in applications of computing and related technologies in education; and
(j) apply computers and related technologies to facilitate emerging roles of the learner and the educator.

Priorities for Pennsylvania's State System of Higher Education During the 90s likewise recommends that "technology should be used in teaching and learning to increase interaction between faculty and students by enabling students to master basic information through interactive computer and/or video technologies rather than by listening to lectures" (Recommendation 11).

Although having clearly begun to address the ISTE recommendations and the State System priority, the College and its regional school district partners have discovered that their faculties have a varied background in technology which hinders the achievement of these goals. Some faculty have sophisticated skills and knowledge and wish to move on to even more complex applications; other faculty are just beginning to explore the interaction with technology and therefore, need basic information and training. This variation in background has led the College and its school partners to place a high priority on faculty development in technology skills, knowledge and application.

In the Fall of 1991, our College began exploring the needs of faculty and area teachers in terms of integrating technology into their professional activities. Faculty identified outcomes for themselves as well as their students, in terms of technology competence and applications. In addition to identifying desirable outcomes, they also identified the skills and knowledge needed to achieve the outcomes. Among the identified needs were knowledge and skill in using hypermedia, interactive video, integrated software packages, compact disk technology, electronic networks, and desktop publishing. They also identified the need to observe first-hand, model programs effectively using technology. By addressing these needs, the College faculty and area teachers felt they could facilitate and enhance their professional performances.

Assumptions

Two technology-related surveys administered to faculty in the College as well as discussions with regional school district partners indicated that university faculty and school district personnel:

(a) have specific expectations for pre-service/inservice teachers in regard to the use of technology;
(b) are in serious need of training to improve their own skills in the use of integrated software packages, interactive video, hypermedia, desktop publishing and CD-ROM;
(c) want to learn how to integrate technology into the teaching and learning process;
(d) want to know how schools/agencies are integrating technology into the curriculum; and
(e) want to be able to assist each other with the integration into the classroom/setting.

Goals and Objectives

The purpose of this staff development program was to afford faculty members in the College of Education and Human Services and regional classroom teachers opportunities to:

(a) develop an awareness of how technology can facilitate and enhance their professional performance;
(b) participate in a series of "hands-on" technology related workshops which focus on integrated software packages, interactive video, desktop publishing, hypermedia, and CD-ROM;
(c) participate in a series of "follow-up" sessions which reinforce and support the application of content learned in the previously taught workshops; and
(d) explore innovative school programs that effectively integrate technology into the classroom.

The Plan

A proposed sequence of activities was developed to meet the above stated goals and objectives: an intensive, concentrated four-day training sequence intended to increase the technological knowledge and expertise of faculty of our College and selected faculty from regional partner schools; and a sequence of four evening follow-up sessions during which the initial training was reviewed and applied to current or anticipated instructional applications. Sessions were designed to have successive sessions build upon and extend previous experiences, beginning with the use of basic integrated software packages and advancing through authoring systems, desktop publishing and the use of interactive video. The initial intensive training sessions were scheduled during the first intersession between the end of the spring semester and the beginning of the first summer session, a period during which faculty and regional educators were able to commit the necessary time without the typical demands of the academic year that would preclude their participation in such an in-depth experience.

In an effort to maximize retention and to stimulate active integration of educational technology into the instructional planning and practice of faculty, four follow-up sessions were conducted paralleling the scheduling of the initial spring training. During each session, faculty worked independently and in concert to practice specific skills in an applied context, in particular, in attempts to integrate technology into their course content and instructional practices. Consultants were available to help faculty extend control over educational technology, for example by trouble-shooting problems or answering specific questions regarding implementation of technology. Follow-up sessions were scheduled on consecutive Wednesday evenings early in the Fall semester. In addition, faculty and teachers from the region visited several model programs, in both K-12 and higher education, where the emphasis was on effective integration of technology into classroom instruction and curriculum.

Funding for this project was secured by a State System of Higher Education of Pennsylvania technology integration grant written by the College of Education technology committee. It might be of interest to note that while the project was funded, one reviewer noted, " ... I question why familiarity with technology is not a *given* in a College of Education faculty. I believe it should be a natural process of keeping current in one's field. The technology under consideration is, for the most part, *not* particularly difficult — given access, one should easily be able to pick it up." This attitude that technology will be acquired independently, in our view, keeps too many teachers locked in the seventies classroom.

Results

Through the workshops and site visitations, the faculty in our College and participants from area schools have:

(a) demonstrated their awareness of technological applications in their courses;
(b) increased their use of technology in the teaching/learning process through methods other than lecture;

(c) increased professional productivity through integration of technology;
(d) developed a network of professionals in our College and among local educators;
(e) developed partnerships between higher education and basic education to increase technology use at both levels; and
(f) observed technology applications in model academic programs.

Examples of their new expertise were observed through:
(a) interactive video and CD-ROM applications in Social Studies methods courses;
(b) student generated data bases in Children's Literature courses;
(c) the collection and compilation of statistics in Educational Psychology courses;
(d) the integration of software/ CD-ROM and reading lessons in the Reading Lab;
(e) HyperCard stacks developed by students;
(f) spreadsheet grading systems; and
(g) eye-appealing handouts, charts, graphs, transparencies and syllabi for classroom instruction and professional presentations.

Training programs such as this can move teachers from the seventies to the nineties; more significantly, they are the vital keys to unlocking the technological doors to the twenty-first century.

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Curry School of Education Windows Transition Project

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The Windows Transition Project involves the transition from the use of the MS-DOS to MS-Windows operating system by the Curry School of Education faculty and staff. It is also an exploration of the utilization of peer support groups as a learning tool for making the transition. Peer groups have been successfully employed at the Curry School for support of other applications such as word processing and electronic mail.

Problem

The University of Virginia Curry School of Education has been acquiring increasing numbers of 386 and 486 desktop computers for administrators, faculty, and secretaries. However, the majority of the staff are still using MS-DOS software and have not yet taken advantage of the MS-Windows graphical user interface. The Curry School maintains a local area Ethernet network which provides access to Novell and Unix servers supported by the school. The local area network, in turn, is linked to campus-wide services and to the Internet. All faculty have either a Macintosh or an Intel-based (80286, 80386, 80486) desktop computer linked to the network.

In order to take full advantage of the capabilities of MS-Windows, native applications for services such as electronic mail, telnet, Internet File Transfer Protocol (FTP), and related capabilities were required. These services were dependent upon installation of appropriate network drivers which supported TCP/IP. The University computing center was in the process of reviewing similar issues during the same period, and determined that campus-wide support would be based upon Novell LAN Workplace. The Curry School volunteered to serve as an early adopter, evaluating the suitability of this solution and associated issues.

The Goal of the Project

The goal of the project was to explore the advantages as well as the barriers to adoption of the MS-Windows graphical interface and to develop a recommendation as to whether this was an appropriate time to make the transition. (The long-range strategic goals of the Curry School included support for use of graphical interfaces on both Macintoshes and Intel-based machines.) By working intensively with a small number of early adopters, it was hoped that problems associated with the transition could be identified and resolved before large numbers of faculty and staff began using the system.

Many of these problems centered around the technical issues associated with provision of full network access from within MS-Windows. Another focus of the transition analysis team addressed the types of applications which might best serve as an initial introduction to the MS-Windows environment. In the case of secretarial staff, word processing became a central focus with emphasis on transitioning from MS-DOS WordPerfect 5.1 to Microsoft Word for Windows 2.0. Since faculty members have different priorities for using different Windows software (e.g. databases, spreadsheets, statistical packages), desktop presentation software was selected as a beginning point for faculty efforts.

Windows Transition Efforts

One faculty member and one secretary were chosen as representative staff for the initial transition project. Two Instructional Technology graduate students worked independently with each staff member. Instruction in Microsoft's Word for Windows 2.0 was used to introduce the Windows graphical user interface to the secretary. The faculty member was offered an introduction to Microsoft's Powerpoint 3.0 presentation software to be used in the classroom, in the conference hall, and in satellite broadcast programs. After several sessions of providing one-on-one tutoring sessions, a learning packet or "Getting Started" document was developed for both Word for Windows and Powerpoint for use in future in-service training programs.

Establishment of a Windows Transition "Focus" Group

Becker (1993, p.32) reports that one factor in the exemplary use of computers is the development of a "strong social network of many computer-using teachers who themselves have gained expertise through extensive computer experience." In order to capitalize on the use of such a network, a "focus" group of three computer-using faculty members was formed. The purpose of the focus group was

(1) to establish a peer group for support of MS-Windows, and
(2) to provide feedback in planning future staff development activities.

The three faculty members represented differing levels of experience. One faculty member with extensive experience with both Windows and presentation software agreed to serve as a peer consultant. After an explanation of the Windows Transition Project and a demonstration of the possible uses of presentation software to enhance college level teaching, several recommendations for continued efforts were established.

Recommendations for Windows Transitions Efforts

The Windows Transition Project Focus Group made several recommendations for future staff development activities:

(1) provide brief training sessions in Microsoft Windows 3.1, Word for Windows, and Powerpoint presentation software to interested faculty and staff throughout the Curry School.
(2) provide on-going support for users of MS-Windows applications and related services such as electronic mail, telnet, and Internet File Transfer Protocol (FTP).
(3) foster and take advantage of collegial social networks and collaborative learning groups as a means of in-service training and peer support as an alternative to independent and separate training groups;
(4) explore the possibility of creating Special Interest Groups (SIGs) of staff wishing to learn specific software tools (e.g. Windows' statistical software, spreadsheets, courseware development);
(5) explore the development of a special electronic newsgroup conference on MS-Windows on the Curry network server which would be monitored daily by several 'experts' to share ideas and find solutions to questions posed by Curry faculty and staff.

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The Mathematics Learning Forums Online

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The Mathematics Learning Forums Project, funded by the Annenberg/CPB Math and Science Project, is a collaborative partnership between Bank Street's Graduate School of Education, the Center for Children and Technology (CCT), and PBS Learning Link. This project builds upon Bank Street's expertise in training leaders in mathematics education, and a CCT project that investigated using telecommunications technology as part of the Math Leadership Program. The Mathematics Learning Forums Project applies the capabilities of new technologies to solving old problems. It draws three strands of work together in a new way to address the challenge of improving mathematics instruction in our schools. The first strand is the field of mathematics instruction itself, where the need for sweeping reform is now well documented in The National Council of Teachers of Mathematics' [NCTM] *Curriculum and Evaluation Standards for School Mathematics*, and *Professional Standards for Teaching Mathematics*, and elsewhere. The NCTM Standards present a framework for reform that is the product of three years of research, planning, and consensus-building by NCTM's Commission on Standards for School Mathematics. The second strand is the use of telecommunications and video technologies as highly effective tools for professional development. The third is Bank Street's unique model of teacher education.

At the heart of a Bank Street graduate education is the advisement process. Advisement is designed as a multifaceted process which enables students to integrate the study of theory with practice in a reflective and self-conscious fashion. Each student works with a faculty advisor and a small group of students (from six to eight) in a number of different ways, one of which involves weekly conference group meetings in which students collaborate on understanding the challenging issues that face them as educators in their field placements. The process encourages students to develop personal knowledge that is connected to their educational practice, and to issues in educational research and reform.

The goal of the Mathematics Learning Forum's project is to expand the Bank Street advisement model through the use of telecommunications seminars designed to engage teachers (grades K-8) in *reflective* and *instructive* conversations about content, learning, teaching, and assessment issues in mathematics. Each Learning Forum consists of an eight week on-line seminar on a specific topic (e.g., estimation, cooperative problem solving, engaged learning, focused observations), involving a group of teachers (8-10) from different schools and different regions of the country. PBS Learning Link is providing the infrastructure and technical support that make the on-line seminars possible, and in the early phases of the project participants in the Learning Forums will be drawn from the more than 20,000 educators that use the Learning Link network.

Teachers will have the option to participate in each Learning Forum on a subscription basis for graduate or inservice credit, or for personal enrichment from Bank Street College of Education. Currently the cost of a Forum to PBS Learning Link subscribers[1] is $480 for graduate credit, $200 for inservice credit; and $150 for personal enrichment.[2] After registering for the Forum a teacher will receive a set of video-based materials and curriculum questions and activities which comprise the shared content of the seminar. Each Forum will be hosted on-line by a faculty advisor who will initiate and provide reflective advice and instruction around the weekly activities.

The project began in July 1993. The first year involves ongoing research and development, in which sixteen forums are being created. We are currently designing activities; selecting, editing, and occasionally shooting video materials; refining the overall structure and format of each forum; and conducting formative studies to aid in the design and development process. In September 1994, we will begin the first nationwide implementation of the Learning Forums, with each forum being offered twice during the academic year. Research will be conducted that will enable us to make revisions in the forums and aid us in developing guidelines for training additional on-line advisors. Beginning in September 1995, the sixteen revised forums will be offered again and with more frequency, and eight new forums will be created. The revenues that are generated from the forums will be used to develop new forum materials and to ensure the project's continuation beyond the duration of the three year grant.

Bank Street's Mathematics Leadership Program

The Mathematics Learning Forums project builds on Bank Street College's expertise as an educator of elementary and middle school teachers in the area of mathematics. For the past ten years Bank Street has run a master's degree inservice program for teachers who wish to become effective mathematics leaders in their schools. The Mathematics Leadership Program is based on the approaches outlined in *Everybody Counts* and the NCTM's *Curriculum and Evaluation Standards for School Mathematics*, and is designed to genuinely integrate the NCTM *Standards* into the curriculum. It educates experienced teachers who do not necessarily have a strong foundation in mathematics to become leaders in mathematics education. The program integrates three themes: 1) increasing mathematical knowledge; 2) building skills as a staff developer and leader; and 3) learning appropriate methodologies for teaching mathematics in a technological society in which it is increasingly important to meet the needs of under-represented populations. Teachers deal with such topics as school change processes, involving teachers in the change process, and understanding the different needs of diverse populations of students. In each of three summers, the mathematics leaders take courses at Bank Street. During the academic year, they focus on improving mathematics teaching in their schools. Graduate faculty provide ongoing support; the teacher leaders, in turn, work with their colleagues to design and teach mathematics curriculum.

In general, the Bank Street approach to teacher education supports the teacher in developing reflective practices. It has conceptual parallels with current research on teacher cognition, which finds that good teachers should be reflective, thoughtful, decision makers and professionals whose plans are influenced by their theories and belief systems and have real consequences in the classroom (Carpenter & Fennema, 1988, 1991; Clark & Peterson, 1986; Lampert, 1985, 1986, 1988, 1991). The Bank Street approach is also consistent with recent attempts to link mathematics assessments to cognitive theories of students' beliefs about mathematics (Nicholls, Cobb, Yackel, Wood, & Wheatley, 1990), their reasoning about quantitative situations (McKnight, 1990), and their organization of problem-solving knowledge (Marshall, 1990).

When used in the Mathematics Leadership Program, this approach supports the creation of mathematics communities where mathematics functions as an interactive as well as an individual constructive activity (Bauersfeld, 1980; Cobb, 1990; Confrey, 1987; Steffe, 1987; Yackel, Cobb, Wood, Wheatley & Merkel, 1990). Engaging in learning as a social activity, Bank Street math leadership students receive feedback on and challenges to newly formed ideas that encourage them to better conceptualize and communicate their thoughts. Opportunities to construct mathematical knowledge thereby come from attempts to resolve conflicting points of view (Perret-Clermont, 1980), to reconstruct and verbalize a mathematics idea or solution (Levina, 1981), and to construct a community of learners within which to coordinate mathematical activity with that of others. In this setting, teachers are indeed "taught in a manner similar to how they teach" (NCTM, 1989). They, like their students, learn in a setting whose goal is "taken as shared meanings" agreed upon by the people in a classroom, a process of both acculturation and individual construction (Cobb, Wood, Yackel, 1991).

Telecommunications and the Mathematics Leadership Program

During the 1992 - 93 academic year, researchers at the Center for Children and Technology, the graduate faculty, and a group of first-year teachers in the Mathematics Leadership Program experimented with the role that telecommunications technology can play in helping teachers to reflect upon, conceptualize, and construct the mathematical ideas and processes that are at the core of this program. Eighteen first-year graduate students and six faculty were given laptop computers. They were also given 2400 baud modems and software — Microsoft Works — and accounts on WNET's Learning Link. Learning Link set up an on-line forum for this project — The Bank Street Math Leaders' Forum — that contained a bulletin board for posting messages, a discussion center for conversation on different topics, and a file library for curricula. The Forum was open only to members of the Mathematics Leadership Program, and required that members use a password to gain access to it. Graduate students and faculty were also able to make use of Learning Link's private e-mail capabilities.

In this small-scale experiment, the telecommunications technology was seen as a way to continue, facilitate, and support the work teachers had begun during the summer

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semester. In order to explore the effectiveness of the network for the graduate students and faculty involved, CCT researchers tabulated the number of messages posted in the discussion center or on the bulletin board, or sent as private e-mail to the project coordinator, and analyzed the issues and themes that emerged in the faculty-teacher discussions (Honey & Hupert, 1992).

The findings suggest that once the teachers and faculty reach a certain comfort level with the telecommunications technology they can go on to have a range of substantive conversations about issues that are at stake in their teaching and learning. Teachers began to use the Forum to discuss particular mathematical problems that they were struggling with in their teaching, and to gather substantive, content-based information. Teachers also used the Forum to post queries and share information about interesting problem-based activities that they could do with their students.

The findings from this research suggest that telecommunications activities can be used as highly effective inservice tools for teachers who are working on implementing a set of shared ideas and practices. This research corroborates other studies that have found that ease of access coupled with common goals and activities are factors that are critical to the success of telecommunications projects (Honey & Henriquez, 1993; Levin, Kim, & Riel, 1988; Levin, Rogers, Waugh, & Smith, 1989; Riel, 1985, 1987; Riel & Levin, 1990; Ruopp, Gal, Drayton & Pfister, 1993; Weir, 1992; Weir, Krensky, & Gal, 1990; Watts, 1992). Research carried out in relation to the TERC Star Schools project (Weir, 1992) confirms that "network exchanges present a prime opportunity for collaboration among teachers. In principle, teachers join a community of learners, where the network becomes a framework for cooperative learning and the scaffolding for teacher learning. The network serves as a forum to share expertise, to try out new ideas, to reflect on practices, and to develop new curricula" (p. 5).

Telecommunications overcomes a number of obstacles to professional development that beset the working lives of teachers. Their working day is structured and highly scheduled, leaving little or no time for non-teaching or non-administrative tasks, and few if any opportunities to attend meetings or classes on a regular basis. In addition, they have limited opportunities to interact in an ongoing, collaborative fashion with their colleagues in other schools whose different experiences and perspectives can add valuable new dimensions to problem-solving. Finally, telecommunications provides a cost-effective means for delivering "personalized" inservice instruction to large numbers of teachers in different places. Specific telecommunications projects have aimed at providing support to beginning teachers (Merseth, 1989; Beals, 1990), and others have focused on efforts to reduce teacher isolation and serve as vehicles for staff development (Katz, McSwiney & Stroud, 1987; Katz, Inghilleri, McSwiney, Sayers, & Stroud, 1989; Ruopp, Gal, Drayton & Pfister, 1993; Watts, 1992). These have been largely open-ended, informal, and unstructured projects without formal incentives for participation. To date, there have been no telecommunications projects designed to deliver inservice instruction to teachers in the form of short, focused seminars with structured activities, clear goals, and real incentives for participation (Hawkins, 1991).

The Mathematics Learning Forums

The Mathematics Learning Forums project builds upon the academic foundations of the Mathematics Leadership Program and the lessons learned in conjunction with its inservice telecommunications component. The focus of the Learning Forums project is on providing inservice instruction to K-8 teachers in order to help them to implement practices in their own classrooms that are consistent with the goals, envisioned by the NCTM and others, of improving mathematics instruction. Specifically, using the NCTM Standards as a framework, the Forums assist teachers in rethinking and reconstructing their ideas about mathematics in four major areas:

- content (what counts as mathematics)
- teaching (how one teaches mathematics)
- learning (how each of us learns, or constructs knowledge-based on
  personal style, culture, prior experience, modality strengths, & preferences, what counts as evidence of mathematical thinking)
- assessment (how we interpret and evaluate what is going on)

Video and Classroom Activities

The materials that serve as the centerpiece of each Learning Forum include both video and print. Video is a powerful tool for modeling, demonstrating, and exemplifying teaching practices and techniques as well as for detecting and analyzing learning processes of students in the context of the dynamic classroom environment. Videotape can enable the viewer to attend selectively and repeatedly to specific events, group dynamics, individual responses, and nuances of behavior exhibited by all participants. Events and interactions can be examined repeatedly, enabling different interpretations and provoking discussion about teaching and learning that is not possible when events are simply recounted. Video materials used in the Forums consists of excerpts of existing video footage from real classrooms and learning settings, and video excerpts are selected to exemplify or model particular techniques, concepts, and activities specific to the topic of the Forum.

The role of the video is two-fold. First, video images are intended to serve as a common "text" for each Forum participant, and will portray the issue at hand in a lively and compelling way. Teachers are able to see other practitioners implement with varying degrees of success a range of mathematically-based practices. Second, and perhaps more importantly, the video serves as a backdrop against which participants will represent their practices, students, and classrooms to other practitioners and the faculty advisor. Building an understanding of each other practices is important to both the group dynamic and the advisor. Without an understanding of who forum participants are the advisor will not be able to do her/his job effectively, and the evolution of the forum as a reflective and constructive community will be impaired.

Each video is accompanied by print based materials that consist of activities that participating teachers are responsible for trying out with their students, and questions that guide their reflective on-line conversations. The activities are designed to be flexible so that teachers can interpret and implement them in ways that make sense for their students and classrooms. We see flexibility as an important ingredient in the design of all forum activities. While the mathematics reform community holds a vision of what teaching and learning should look like, the reality of the ways in which this vision is put into practice in classroom settings will vary enormously. We wish to support teachers in the process of becoming reflective practitioners and learners within their own communities, and we want to be able to acknowledge and support the many ways in which this can be realized.

Telecommunications as a Tool for Professional Development

The advantage of using a telecommunications network to carry out the Mathematics Learning Forums Project is not only its ability to provide services to large numbers of teachers across the country, but its capacity to bring together new communities of learners in a reflective and constructive fashion. Inservice instruction is not merely about the dissemination of information, but is a process that involves thoughtful and reflective conversation about a range of issues. The Learning Forums project is intended to provide teachers with an opportunity to reflect on their current practices and to work on transforming these practices in ways that make sense given both the possibilities and limits of their own classroom settings.

There are three important features that are operative in this project and that we believe are necessary if telecommunications is to be used much more broadly as a vehicle for the professional development of educators. First, the Forums are intended to *fit into teachers' daily routines* with the least possible disruption to their already busy lives, and they *offer real incentives for participation* in the form of graduate or inservice credit. The fact that each Forum will run for an eight-week period means that teachers can complete the course within a manageable time frame, while successfully fulfilling requirements for continuing certification or professional advancement. Second, teachers are able to *integrate the work of the Forum directly into their classroom practices* and receive reflective and instructive feedback on their efforts. The activities that teachers try out with their students are flexibly designed so that teachers can interpret and implement them according to their own and their students needs. Forum advisors are available to offer constructive guidance throughout the eight weeks. Third, the Forums *provide content that builds on existing reform efforts* — in this case the NCTM Standards. The instructional focus of the Forums, thus meets administrators' and district curriculum coordinators' needs to supply training in helping teaching faculty rethink and redo their mathematical practices. It is our hope that this combination of features of the Learning Forums project will not only result in success, but will serve to stimulate the development of additional telecommunications-based professional activities for K-12 educators that meet the needs of our nation's many committed practitioners.

[1] PBS Learning Link is currently available in 25 sites across the country. In many of these sites the service is offered free of charge to educators, and in many others it is available at a nominal subscription rate. Information is available, upon request, about the location of Learning Link sites and subscription costs.

[2] Prices are subject to change overtime.

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High-tech, High-touch Initiatives at a Traditional Teacher Preparation Institute

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In 1989, the North Dakota State Legislature mandated a state-wide system of higher education. In response to this mandate the State Board of Higher Education challenged each institution to define its unique strengths within the system.

The faculty and administration at VCSU described their strength as being a premier institute for teacher education with an emphasis in technology applications to instruction. This proposal reflected not only our historic and constitutionally mandated mission of teacher education, but also a recognition of the increasing role of technology in the delivery of instruction and explained why VCSU was well suited for assuming a leadership role in this area.

February 1, 1990 The State Board of Higher Education approved the mission of VCSU to assume a leadership role in teacher education by directing us to develop a special emphasis in instructional technology.

Technology and Training

The first theme involves the acquisition of technology and training faculty and students in its use. Many of the methods classes are phasing in a computer component as part of the curriculum. Most of the English composition classes are taught in one of the five computer labs.

In the effort to develop this mission at VCSU, three goals soon became clear:

1. All graduates of teaching programs will receive instruction and significant experience teaching in a multi-classroom environment supported by telecommunications and computers.
2. All graduates of teaching programs will receive significant comprehensive instruction and experience with computers in the classroom environment as related to their academic discipline. This goal reaches beyond mere literacy to include skills such as classroom management using computers.
3. All graduates of teaching and other programs will experience an education that by example will demonstrate the advantages of computer-enhanced instruction in all its diversity. Thus every instructor on campus will have ready access to multimedia teaching stations and necessary software for effective use in all classes.

One of the first classes to change was the Educational Technology class. The class was reorganized to take advantage of information technologies in the computer labs and the distance education laboratory installed in 1990. In the Macintosh lab the students learn to use a word processor, graphics program, scanning, sound editing and HyperCard. A third of the semester is spent in the lab creating projects.

Two adjoining rooms are used for the distance education lab. An interactive video system connects the two rooms. The lab closely resembles the actual eleven studios of the North Dakota University System in set-up and equipment operation. All teacher education students are given the opportunity to give a presentation over the closed circuit system. They get experience in creating visual materials and in planning lessons suitable for video format.

Concerns

It has been easy to introduce technology into classes such as the English Composition and Educational Technology. The instructors saw the obvious advantages of doing so. However, there were and still are obstacles to spreading the technology into other classes. The two major obstacles were a lack of equipment and experience with computers. Fewer than half of the faculty had computers in their offices in 1989. The lack of equipment was solved through concerted efforts and creative financing from the administration. By the fall of 1993 all faculty had computers on their desks. There were also ten multimedia carts with stereo monitors, laser disc players, CD-ROM drives, and sound mixers that could be connected to any of the computer platforms, and a multimedia production station. With five computer labs on campus the computer/student ratio is better than one to nine.

Training the faculty to use the technology was a more difficult obstacle to overcome and remains a problem today. In 1991 a full time position was created for academic computing support. At that time administration set aside one day a semester for faculty technology training. These steps helped but were insufficient to bring all the faculty up to the point of using technology in the classroom. The technology days were discontinued in the fall of 1993. A new workshop format was tried. The first one was on using e-mail. The faculty enjoyed this change but since only half of the campus was networked at the time, it was difficult for many to make use of it. The most effective method of training we have found thus far is through peer tutors.

Other problems dealt with the appropriateness of technology. The faculty felt that one of the strengths of the school was the amount of personal contact with students. Students did not come here and get lost. The school was a personalized institution. Some faculty members questioned the new mission and the importance of technology in the classroom. Many faculty members worried that the emphasis on technology would deteriorate the personal atmosphere and might lead to less humane classrooms. When the Center for Innovation in Instruction committee was initially formed and looking for a name, there was a lively discussion about the use of technology in the title. They finally settled on the simple name Center for Innovation in Instruction and avoided any use of technology. Some of these concerns are still being expressed today.

A Major and Minor in Instructional Technology

The committee for the Center for Innovation in Instruction also decided that another way to fill the new mission was to have a major and minor in Instructional Technology. The administration agreed and in the 92-93 school year the committee began to gather information about the need and feasibility for such a program. They found that only four new courses would need to be added to the curriculum to form the course work for the major and minor. They then did a survey of 610 high school seniors and undergraduate students to determine what level of interest existed among the potential students. The results were encouraging. Over 35% said they were somewhat or strongly interested in pursuing a major in Instructional technology even though it would be a double major (it is expected that all Instructional Technology majors and minors will also have a teaching certificate) and could require an extra semester or summer session. Forty-five percent said they would be interested in a minor. The committee also surveyed approximately 50 superintendents in the region and the North Dakota Department of Public Instruction. The superintendents were given a copy of the proposed course work and asked to respond to the need for such a program and how it would affect their decision to hire a graduate with one of the technology degrees. The results were again positive. With few exceptions the superintendents said there was a definite need and that they would be highly likely to hire such a teacher.

Armed with this and copies of job announcements for positions for the type of individual similar to what the degrees would be producing, the committee prepared a request for the new programs. The administration submitted the request in the Spring of 1993 and it was accepted by the Board of Higher Education. Students will be able to enroll in the programs starting in the fall semester of 1994.

Total Quality Learning

The third theme is the development of a total quality learning culture throughout the entire North Dakota University System (NDUS) starting at VCSU and Mayville State University (MaSU). NDUS proposes to recast the traditional undergraduate education mold. VCSU and MaSU were singled out to be the leaders because in 1992 the two universities started a joint venture of sharing a president, provost and other administrative officers. They were thus already creating an innovative environment. Also the Board of Higher Education felt that this cultural shift was a natural complement to VCSU's technology mission.

To accomplish this goal, NDUS and VCSU submitted a proposal for a grant from the Funds for the Improvement of Post Secondary Education (FIPSE) program. Their proposal was successful and work on the grant began in the summer of 1993. A coordinator for the grant was hired along with an assistant who is also a student. The grant provides for the development of an Innovation Leadership Team (ILT). The team has been formed and is composed of students, faculty and staff from both campuses. The ILT is charged with creating a culture of innovation, development, and continuous improvement in the teaching and learning processes. The ILT is be a catalyst on both campuses in the development of quality innovations and in identifying obstacles to improvements. The team is studying internal structural changes that are needed to create a campus climate that is permission-granting and empowering rather than prescriptive and restrictive.

The NDUS Chancellor has established an NDUS Foundation Board which includes representatives from business and industry. The Board will help support the FIPSE initiative and provide input into the development of the innovations. They are being included because they will be the future employers of many of our students. The Board is a vital link in the improvement process.

The project is designed for a three-year period beginning with the 1993-1994 academic year. During the initial year the efforts will concentrate on Valley City State University and Mayville State University. During the years that follow, faculty participants will be selected from the remaining NDUS campuses. As the project progresses, activities will be developed to encourage interaction among faculty across the system.

Some of the difficulties that the team faces are inherent in developing a collaborative program between two separate institutions who were formerly rivals in many ways. To this point collaboration has not been a serious problem. The schools are both strong teacher education institutes and faculty members have cooperated on other projects before. Most of the problems for collaboration are organizational. Other difficulties are faculty perceptions that this initiative is just another fad and will come and go with no lasting improvement of education. Others are concerned that there may not be jobs for graduates of a school that makes its students partners in the educational enterprise. These are difficulties that will not go away easily

The Center for Innovation in Instruction

The Center idea was pursued further beginning in the Spring of 1993 when a group of 44 North Dakota school districts known as the Southeast North Dakota Telecommunications Consortium (SEND), in cooperation with Valley City State University, wrote a response to a request for proposals from the North Dakota Educational Telecommunications Council (ND ETC). The ND ETC sought specifically to fund proposals that include a comprehensive way to train educators throughout the state in a manner that supports, supplements, collaborates, and/or cooperates with the K-12 educational technology mission charged to Valley City State University, the K-12 and Higher Education Computer Network services provided by SENDIT (public school state wide computer network) and ODIN (North Dakota on-line library service), and/or the K-12 services provided by Prairie Public Television and the various interactive television clusters.

The Center partnership, including VCSU and the original 44 school districts, with the support of the State Board for Vocational Education, State University Chancellor's Office and State Department of Public Instruction, received start-up funds from the North Dakota Educational Telecommunications Council to establish the Center for Innovation in Instruction on the campus of Valley City State University. Matching funds for developing the Center came from the State University System.

During the current school year, 1993-94, the Center for Innovation in Instruction is developing and testing its services with the 44 SEND schools, while seeking input from teacher educators, K-12 educators, and technology leaders throughout the state. Beginning in September, 1994, the Center will begin offering services and training to all schools in North Dakota. The development plan for the Center calls for assessment of customer needs, service development, testing, implementation, evaluation, improvement, and service expansion.

Based on the results of the test-group needs assessments, the following services are expected to be developed:

- Workshops to meet the needs of teachers and administrators
- Newsletters and publications
- Organization and support of technology educator learning groups
- Research to describe current practices, validate innovations and assess effectiveness
- Hardware preview center for educators to test equipment before purchase
- Planning assistance, preparing educators for change
- Product development to meet needs not filled by existing commercial ventures
- Software evaluation and preview library
- Licensing and legal assistance to aid educators in maintaining appropriate use of software and video
- Technology Leadership Institute designed for technology coordinators, principals and superintendents
- Brokerage of external services that firms or individuals direct toward schools
- Close cooperation with VCSU and MaSU in the total quality learning changes in the teacher education courses.

Conclusion

All of these changes are ongoing; some of them are just beginning. We anticipate that the direction we are heading now will not be the final destination. The underpinning goal is to create a culture where change is encouraged and examined carefully for its impact on the learner. We (the authors) are continuously working on documenting the processes involved and the results of the changes. We will be happy to share the information with interested colleagues.

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Establishing a University-Public School Educational Technology Consortium

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Several K-12 educational technology consortia have been established in Virginia. Two, the Consortium for Interactive Instruction (CII) and the Educational Technology Consortium (ETC) are affiliated with public television stations (WHRO in Norfolk and WCVE in Richmond, respectively). A third educational technology consortium, Novatec, is comprised of a consortium of school divisions in Northern Virginia.

The Curry School of Education is in the process of exploring the establishment of a University-Public School Educational Technology Consortium. This consortium would be loosely modeled upon the existing educational technology consortia and would build upon a history of informal collaborative partnerships between the Curry School and surrounding school divisions which are already in place.

Past successful University-Public School collaborations have included Teacher-LINK, a K-12 networking project which eventually led to the establishment of a statewide K-12 Internet network in Virginia. More recently the Curry School and a local school division have agreed to jointly share the cost of an educational technology facilitator who is coordinating an array of collaborative efforts between preservice teachers enrolled in educational technology courses and classroom teachers in the process of integrating educational technologies into their curricula.

In formative discussions, participants from the Curry School and instructional technology branches of local school divisions have agreed upon adoption of the title of "Monticello Regional Technology Consortium" (due to the close association of Jefferson's home with this area of Virginia, and because of Jefferson's life-long interest in adoption of innovative technologies). In initial meetings some of the suggested goals for the consortium have included:

- development of a regional educational technology newsletter
- establishment of a software preview center
- creation of a speaker bureau
- development of shared instructional technology classrooms
- generation of a regional calendar of technology-related events
- development of an annual technology conference

More generally, it is hoped that collaboration among K-12 schools and schools and colleges of education can result in important synergies for each. Teachers often teach in the same way in which they were taught. For that reason, it is important for teacher education students entering the classrooms for the first time to encounter classroom teachers who effectively model successful uses of instructional technologies. It is therefore to the advantage of schools of education to assist nearby K-12 schools with technology infusion efforts. At the same time, such collaborative efforts can serve as laboratories which make it possible to determine which emerging technologies can be successfully employed in real-world classrooms. This information, in turn, may shape instructional technology goals in the preservice teacher education curriculum.

Mary Dietz, the current president of the Association of Colleges of Teacher Education (ACTE), has suggested that K-12 schools and colleges of education must "simultaneously reinvent themselves." Collaborative partnerships offer the opportunity to do precisely that.

The effect of the consortium on technology integration within the school of education has not yet been reviewed. The Monticello Regional Technology Consortium is striving for effective means through which technology can be integrated into traditional classroom practice in ways that enhance learning and instruction.

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A Texas Professional Development and Technology Schools Project

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In 1993, the University of Houston began developing a consortium of four area universities, eight Professional Development and Technology Schools, and local educational service agencies. The primary goal of the consortium was to prepare teachers for urban, multicultural classrooms. Funded by a grant from the Texas Education Agency, the multi-year project known as The Houston Consortium of Urban Professional Development and Technology Schools, seeks to attenuate several persistent problems in teacher education by training teachers who are both sensitive to the needs of an urban, low socio-economic status, and culturally diverse population, and who are capable of integrating technology into their instruction. This paper outlines some of the activities involved in implementing the Consortium program during the first year of operation.

Organization of the Consortium

The Consortium includes four major Houston area universities which certify teachers: Houston Baptist University (HBU), Texas Southern University (TSU), University of Houston (UH), and University of St. Thomas (UST); three large school districts, which collectively educate more than a quarter of a million students: Houston Independent School District (HISD), Spring Branch Independent School District (SBISD), and Alief Independent School District (AISD). The consortium also includes two regional educational support centers, Region IV Education Service Center and Harris County Department of Education. These two agencies serve more than 24 urban and mid-urban school districts.

In the first year the Houston Consortium includes eight Professional Development and Technology Schools (PDTSs): seven elementary schools and one middle school. The Consortium PDTSs employ 647 staff members who serve a culturally, ethnically, and economically diverse, urban student population of 5,481 youngsters. Plans call for adding six more PDTSs in the second year of the project (two high schools, two middle schools, and two elementary schools).

After many meetings, discussion groups, and planning sessions that involved K-12 teachers and administrators, teacher educators, and a number of consultants, a set of ten guiding principles for the consortium emerged:

- School-based and Learner Centered – Professional development and technology schools provide the authentic settings for preservice teachers to learn to teach urban children and youth more effectively.
- Outcomes Focused – Progress through and completion of the program by preservice teachers is based on demonstration of outcomes considered important to improved urban education.
- Rich in the Use of Technology – Technology is used in the program of teacher preparation and in the professional development and technology schools for management, instruction, and communication.
- Focused on Cooperative Learning – Cooperation and collaboration are major concepts that guide the program.
- Strongly Identified with Cultural Diversity – The program is designed to develop understanding and

regard for cultural and economic diversity, as well as diversity of abilities (e.g., special education and gifted and talented) and motivation.

- Reflective and Investigative – The program promotes and utilizes reflection upon and analysis of contexts, actions, and outcomes so students understand and improve the educational process.
- Based on Active Learning – The program facilitates learning by engaging prospective teachers in exploring, experiencing, and applying theoretical constructs to field-based experiences. Everyone-university professors, teachers, and prospective teachers-consider themselves active learners.
- Broad in its Range of Teaching Practices – Preservice teachers experience and learn to use current best teaching practices and strategies.
- Strong in Liberal Studies Background – A rich and broad liberal education, complemented by strong academic preparation in the teaching fields, is expected of all preservice teachers.
- Grounded in Authentic Assessment. Portfolio assessments are used to assess and demonstrate a broad range of abilities. Prospective teachers are expected to maintain a portfolio of their accomplishments both as a demonstration of progress and as an employment aid.

Each of the four universities in the consortium is developing a teacher education program. And while the programs differ considerably, they all are based on these principles. In the remainder of this paper the program being developed at the University of Houston will be discussed.

PUMA (Pedagogy for Urban and Multicultural Action)

The University of Houston component of the Consortium project, PUMA (Pedagogy for Urban and Multicultural Action), has as its goal the creation of a technology-rich environment that supports the development of successful educators for the urban environment. For instance, notebook computers with modems were purchased and loaned to the emerging teachers so that they can take advantage of Internet resources.

In addition to a significant technological dimension, PUMA is designed to overcome some of the persistent problems in teacher education. For instance, one of the most serious problems of beginning teachers, the isolation felt by student teachers in their teacher education program, is addressed in several ways. Cognizant that technology is not a goal in and of itself, PUMA's philosophy is to utilize the resources of the Consortium, including technology, that can effectively deal with the solitary nature of traditional teacher education.

In this paper, we focus on the characteristics of cooperative learning and how technology, in concert with cohort grouping, can help to reduce the isolation felt by student teachers.

Eliminating Isolated Learning Environments

Learning to teach has traditionally been a private, individual act. While it is true that student teachers are generally paired with one or two cooperating teachers, they are rarely asked to work with other student teachers in the process of learning to teach. Yet, those who work for school renewal and reform maintain that teachers must learn to work together to improve schooling. If teacher educators do not support, encourage, and provide for interactions among student teachers, it is unlikely that beginning teachers will view teaching as a collaborative act. Professional Development and Technology Schools may provide the opportunity for student teachers to explore learning to teach in concert with one another.

Fieman-Nemser and Floden (1986) emphasized how isolated teachers can be, suggesting that the "egg-crate" architecture of the school and the school schedule encourages isolation of teachers, which can be detrimental to a teacher's practice. Similarly, Lortie (1975) noted that the professional isolation of the first-year teacher and the intellectual isolation of all teachers contributed to a number of potentially adverse conditions. Indeed, teacher isolation may contribute to teacher burnout and attrition.

In his extensive review of student teaching, Griffin (1989) found that student teachers, like their experienced counterparts, are very much alone in their work. He described one of his study's primary findings:

> Student teaching can be characterized somewhat as the teaching profession has been—as a lonely profession. In the same way that practicing teachers tend to be isolated from their colleagues by the organization of schools and by the ways in which schools are designed, the student teacher-cooperating teacher dyad appears to be isolated from other dyads and, indeed, from other cooperating teachers and student teachers. (p. 362)

The early isolation of student teachers may lead to experienced teachers who do not view teaching as a collaborative effort. Student teachers who do not form a social network with one another during their teacher training are unlikely to create such networks as beginning teachers. In a study that was specifically designed to examine teachers' social support network, Garabino and Whittaker (1983) found that informal networks among teachers do exist, but tend to be so informal that it is difficult to discover who benefits and how. They also wrote that the most obvious peer support networks, the two national teacher organizations (the American Federation of Teachers and the National Education Association), "are of little help in overcoming the loneliness and isolation that leads many teachers to leave the profession" (p. 272).

In short, the paucity of research on social support networks forced these authors to explore the conditions needed for networking among teachers, rather than exploring programs already in place. They suggest that both the school administration and teacher training institutions can foster informal support networks among teachers; the former by encouraging interaction among teachers; the latter by placing student teachers in cohort groups.

Conoley (1989) suggests that beginning teachers must communicate effectively with both their students and other teachers. She maintains that skills needed by beginning teachers include well-developed communication skills, a deep understanding of how to collaborate with other teachers, the ability to consult with others, and the knowledge of problem solving methods that include working with others. If beginning teachers must have skills in the former categories, are teacher educators preparing preservice teachers to understand these roles? In an age of site-based management and other collaborative endeavors, it is increasingly important for teachers to work well with one another.

Features of Cooperative Learning

Professional Development and Technology School programs may provide the type of student teacher collaboration which can result in better instruction, leading to school renewal. One of the foundations of the Consortium program as well as the University of Houston PUMA model is a strong focus on cooperative learning. Confident that true professionals grow only when they are able to "test their private puzzles" with others who are engaged in similar challenges, students are placed in cohort groups with one another. In addition, the schools are organized around teaching clusters in which student teachers are able to observe their experienced counterparts discussing various aspects of teaching (e.g., student achievement, working with parents). In this way, decisions in the PDTSs are made in concert with others involved and teaching/learning challenges and are not left for the individual to solve in private.

Within PUMA much of the effort to solve the puzzles of teaching is public. In fact, portfolio assessment is the primary evaluation tool of student teachers in the PUMA program. Each student completes two portfolios, one which gives evidence that the student is "safe to start," the other an exit portfolio indicating that the student is ready to assume full-time teaching in his or her own classroom. The importance of collaboration is emphasized in the portfolio presentations. Students present their portfolio to a group of educators, including one of their peers, who has witnessed several lessons completed by the presenting student. Students serving on this committee to help their peers reflect on their growth as teachers, signifies the importance of collaboration.

Another way the isolation of teachers is reduced is through cohort groups. The PDTS concept allows 8-10 student teachers to learn their profession in a cohesive group of learners who work in one school. Because they all face a similar challenge, have similar resources, and come to know the same children, the student teachers become a tightly-knit cohort group. They quickly learn to trust one another and count on each other's advice. As one student teacher recently reported, "We didn't know one another at all when the program started, but now we trust each other with anything."

This comment came after only three months into her experience in the PUMA program. The typical student teaching program acts as though the goal were to "divide and conquer" the student teachers. Placing student teachers in a school with only one or two of their counterparts discourages student teacher interaction at a time when they most need it.

Integration of Technology

A critical goal of the preservice teacher education program proposed by the Consortium and the PUMA model emphasizes use of technology to support classroom instruction, instructional management, and distance education. It also provides electronic communication to reduce the isolation felt by beginning teachers. To stress the use of technology, students are encouraged to use a variety of multimedia resources in the development and presentation of student portfolios.

Through the Consortium, preservice teachers are equipped with knowledge of how to use instructional technology effectively with an emphasis on instructional uses of classroom-based computers, classroom administrative applications, and the use of educational telecommunications. The program gives preservice teachers experience choosing technology appropriate to the needs of their students and provides continuing opportunities for them to practice the implementation of that technology.

All prospective teachers complete an instructional technology course, either in their universities prior to experiences in the PDTS, or as part of the program. Thus, they are knowledgeable about instructional hardware and software and are able to assist teachers in the PDTS in computer-supported instruction. This is not only a valuable learning experience for prospective teachers, but also of paramount importance to PDTS teachers, particularly those who may be less confident of their ability to use technology. Software collections at the local education agencies and the participating universities are available for program participants to examine for possible use in their classrooms.

A number of lightweight portable laptop computers are included as an integral part of the program. These computers are used for lesson planning, telecommunications, record keeping, and instruction. The goal of the program is to educate teachers for whom the technology becomes so transparent that they cannot imagine doing their job without it.

Prospective teachers are able to organize notes from their university classes, obtain files related to the content they are teaching and instructional technology resources that are appropriate for their K-12 students, use templates to organize observations of instruction, maintain grades and records, construct and index lesson and unit plans, develop or secure instructional materials electronically and use the computer and an LCD display unit to support a teacher centered lesson, and keep a log of experiences and innovative ideas. Authentic assessments that are part of preservice teachers' portfolios are also being maintained via the laptop. With a modem and telephone line, preservice teachers are able to communicate with university instructors electronically (e.g., turn in assignments, receive feedback, make appointments), from home or school.

A portable multimedia tation is located in each of the eight PDTSs, at each university, at the two service agencies.. This assures a minimum technology base for instructional use by prospective and inservice teachers in PDTSs and by the trainers of these teachers. Included in the portable multimedia station is a computer and monitor, a color LCD display, a camcorder for recording events and teaching episodes, a scanner, and software for storing and displaying video on the computer. This equipment is stored on two rolling carts so it can be readily moved from one area to another.

A model interactive classroom with six workstations is also being installed in each university so instructors can demonstrate grouping and individualization in their classes. Modeling effective instruction for prospective teachers, including active learning and cooperative learning, are important complements to experiences in schools.

An important component of the project is the use of telecommunications. A suite of telecomputing resources are being implemented to support collaboration and communication among participants, provide access to electronic information resources available on the Internet and through TENET, the Texas Education Network, and the University of Houston campus network. These connections facilitate an intensive use of telecommunications by prospective teachers and teacher educators in their planning and classroom activities. They also allow for ongoing discussion and professional support among preservice teachers, professors, and mentor teachers. An electronic communications station is available in each of the eight PDTSs, each of the four universities, and the regional service centers. The station includes a computer with either a direct Internet connection or a dedicated phone line and a high-speed fax modem. Each station includes a printer, and all of the equipment is housed in an area accessible to preservice and inservice teachers.

Consortium members are linked electronically through electronic mail, a series of online newsgroups, and a consortium gopher site which houses project documents, a consortium directory, instructional software, and links to other Internet resources. All project participants are being trained to use graphical-user-interface Internet resources such as Eudora, TurboGopher, and Fetch over SLIP (Serial Line Internet Protocol) dial-up connections. The SLIP connection allows members who do not have access to a direct Internet connection to access and retrieve a wide variety of information, such as electronic journals, scientific image files, and hypermedia applications from any location. The SLIP connection can be accessed over a modem and telephone line from school or home.

We believe if we can encourage preservice teachers to communicate with each other and with their university and school instructors while in training, they will continue to do so following program completion. Beginning teachers tell us how isolated they feel, how they wish they could remain in contact with their cooperating teachers in the PDTS and that favorite professor in the university following graduation. And perhaps as important, with the widespread distribution of instructional materials on the Internet, consortium members are able to gain a broad view of the multitude of ongoing activities related to teacher education and classroom teaching that exists today.

Technology Education Development and Support System (TEDS)

An additional major technology component of the Consortium is the Technology Education Development and Support System (TEDS). One of the primary responsibilities of the TEDS is to identify and secure technology-related teacher education resources with particular reference to resources that have been found effective with urban populations, and make these resources available to preservice teacher educators in schools, universities, and educational support systems in the consortium. Identification of available teacher education technology materials has begun and a CD-ROM of available teacher education materials is currently being developed for distribution to consortium members.

A second responsibility of the TEDS is to design and develop technology-based instructional materials, including interactive multimedia packages, created specifically for technology-enriched teacher education programs. While there are many ways interactive multimedia can be used effectively in teacher education, few packages have actually been developed. This contrasts sharply with the several thousand packages available for K-12 and other areas of higher education.

As the project advances, professors and mentor teachers will have the ability to provide dramatic, interactive, videodisc simulations of events that preservice teachers are likely to encounter when they begin teaching. The objective of the technology teacher education materials will be to develop reflective inquiry in prospective and inservice teachers.

During the first year of the project, development is underway on a package related to model uses of technology in the classroom . Using hypermedia software, prospective teachers, individually and in small groups, will explore models such as the use of simulations, the concept of anchored instruction, and children's writing and publishing centers. Video segments will be recorded in exemplary classrooms and instructional designers in TEDS will create interactive multimedia packages based on these segments of instruction and interaction.

Summary

The Houston project is one model for addressing the task of preparing teachers for urban schools. The program places students for extended periods of time in professional development schools, provides support for the use of technology in the classroom, and encourages collaboration and communication. The results, at this early stage, are encouraging.

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The First Teacher Education CD-ROM

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Fifteen years ago, in 1979, teacher educators interested in teaching about information technology quickly discovered that relevant software resources were quite limited. Applications software such as word processors and spreadsheets could be adapted for classroom use. And, of course, there was a growing collection of drill and practice, tutorial, and simulation software designed for classroom use. Many teacher educators who demonstrated software in their courses, or required students to evaluate programs, could keep all their program disks in a small plastic box.

The situation has changed drastically since 1979. There are thousands of educational software packages today, and new types of applications software have appeared such as desktop publishing programs and presentation software. Many new forms of educational software have also emerged. Computer-supported laserdisk packages, hypremedia software, and multimedia packages are popular now but did not exist in 1979.

Today the computer-using teacher educator is faced with a problem of overabundance rather than scarcity. There are tens of thousands of public domain and shareware programs that might be of interest to teacher educators. In addition, many commercial software companies now supply demonstration versions of their programs to potential buyers.

The large number of programs available presents two problems. First, sifting through even a small percentage of them is time consuming. Second, if you do take the time to select useful programs, the result can be a scattered collection of several hundred disks that, without constant attention, are never where you need them. The idea for a teacher education CD-ROM occurred to one of the authors (JW) after he had searched through fifty or sixty disks at home only to discover that the program he was looking for (a public domain simulation on neural anatomy) was at the office (or in the computer lab, or loaned to a graduate student).

CD-ROMs are a convenient way of storing hundreds, even thousands, of files in a convenient, portable format. A single CD can store over 600 megabytes of data and costs less than the price of two 3.5" diskettes to manufacture in quantity. Over the past year a group at the University of Houston has been collecting, evaluating, and organizing programs and data files that can be used in preservice and inservice teacher education programs. The CD has been duplicated and is available for a small charge.

Structure of the CD

We used a desktop CD recording system (CD-R)to produce a master copy of the CD. After testing it for compatibility, it was mass produced for distribution. The files on the CD fall into four general categories:

- *Macintosh Files.* One section of the CD contains a collection of files that run on Macintosh computers.
- *IBM Files.* Two sections, one for DOS and one for Windows, contains programs that run on IBM and IBM-compatible computers.
- *Resources.* Several types of resources, such as graphics,

fonts, and sounds, can be used by both IBM and Macintosh computers. The CD has a collection of resource files that are particularly useful in education.

- *Documents.* The fourth section of the CD contains a collection of documents. Some files contain the texts of classic works of literature. Others are papers on different aspects of technology use in education.

Program Categories

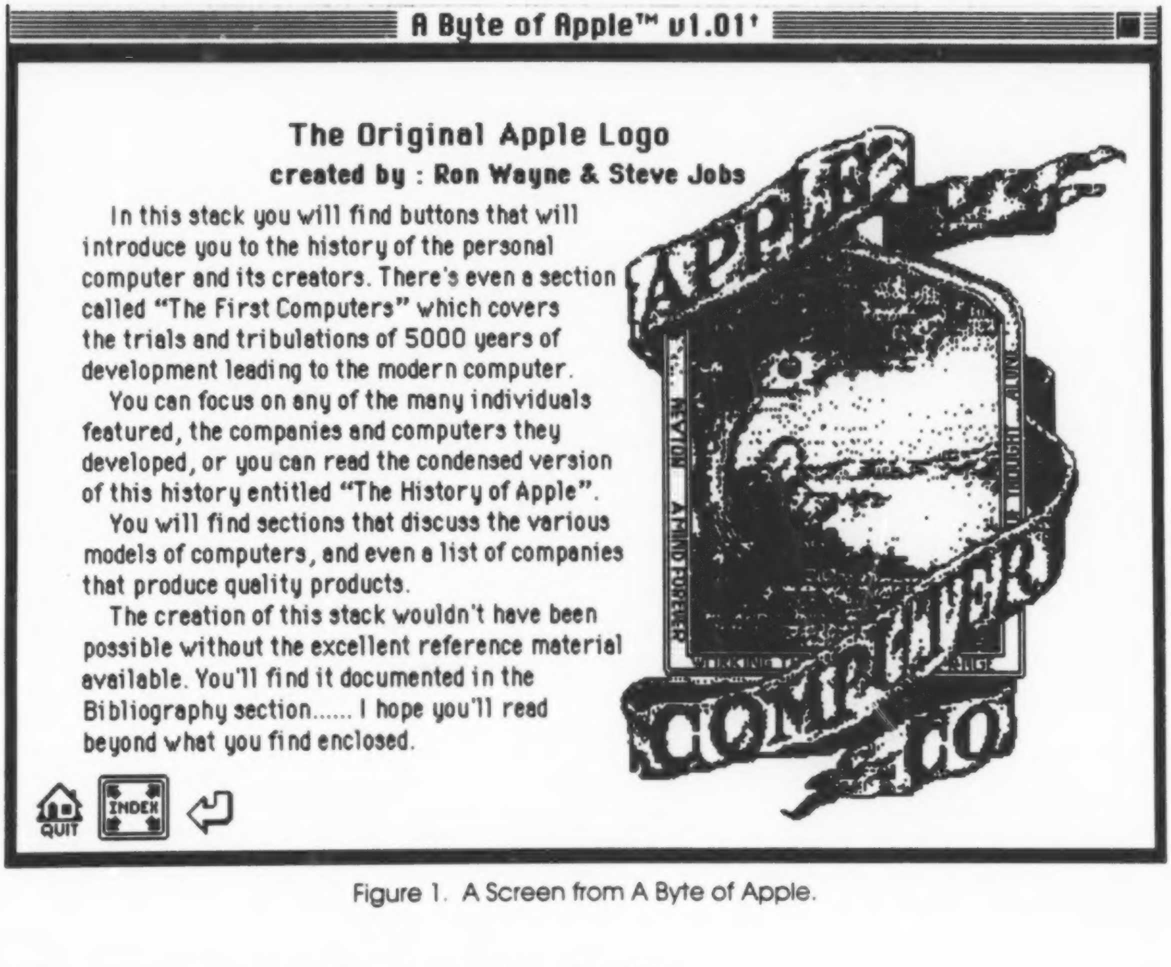
The DOS, Windows, and Macintosh sections of the CD are organized according by software type. There are five general program categories:

- *Communication.* Software in the communication subdirectory includes public domain telecommunications programs, tools for accessing commercial networks such as CompuServe, and software that automates Internet use.
- *Instructional Technology.* Programs related to instructional technology and computer literacy are stored in this area. For example, tutorials on computer operation and the use of popular applications software are available.
- *Productivity Software.* Subdirectories or folders contain a wide range of applications programs including spreadsheet programs, word processors, authoring tools, and gradebook software.
- *Subject-specific Software.* The CD includes a number of programs designed specifically for use in education. Subdirectories or folders contain programs for areas such a language arts/reading, mathematics, science, social studies, special education, business education, and the arts.
- *Fun.* The CD includes a number of games for both Macintosh and IBM computers.

A Sample of Material on the CD

A few of the files on *The First Teacher Education CD-ROM* are described briefly below:

- *A Byte of Apple.* This program, in the Information Technology folder of the Macintosh section is a HyperCard stack that covers the history of computers with an emphasis on Apple computers. Figure 1 is from this program.



The Original Apple Logo
created by : Ron Wayne & Steve Jobs

In this stack you will find buttons that will introduce you to the history of the personal computer and its creators. There's even a section called "The First Computers" which covers the trials and tribulations of 5000 years of development leading to the modern computer.

You can focus on any of the many individuals featured, the companies and computers they developed, or you can read the condensed version of this history entitled "The History of Apple".

You will find sections that discuss the various models of computers, and even a list of companies that produce quality products.

The creation of this stack wouldn't have been possible without the excellent reference material available. You'll find it documented in the Bibliography section...... I hope you'll read beyond what you find enclosed.

Figure 1. A Screen from A Byte of Apple.

- *Gradebook 2.02L.* This program, in the productivity/classroom area of the Macintosh section, is a shareware gradebook program with many features. Figure 2 is a screen shot from the program. A program named Grade Book Power is a similar program in the DOS section, and GradeBook for Windows is provided for Windows users.
- *HyperStudio Preview.* This is a demonstration of a popular hypermedia authoring system from Roger Wagner Publishing.
- *MacDraw Pro 1.5.* This is a demo version of a popular drawing program from Claris.
- *ViruScan.* This program looks for and removes viruses found on your disk. It is considered by many to be the best program available for the Macintosh. It is in the Utilities folder.
- *PC Proof.* A DOS program in the productivity/word processing subdirectory, it checks the grammar of your document. It can identify a number of problems such as subject/verb agreement and passive voice. It works with most popular DOS word processing programs.
- *MathPlot.* A DOS program in the subject/math subdirectory, MathPlot graphically displays the plot of a math function you write in standard algebraic notation. It can handle cartesian, polar, and parametric equations. Plots can be displayed on the screen or printed.
- *HyperPad.* This program, in the productivity/authoring subdirectory of the DOS section, is a commercial program that became shareware a few years ago. It is a powerful authoring environment for creating hypermedia documents that include text and graphics.
- *LessonPlanZ.* A DOS program in the productivity/classroom subdirectory, it automates the process of developing and storing lesson plans. It can generate several different types of reports and will even produce labels for the folders you use to store the printed lesson plans.

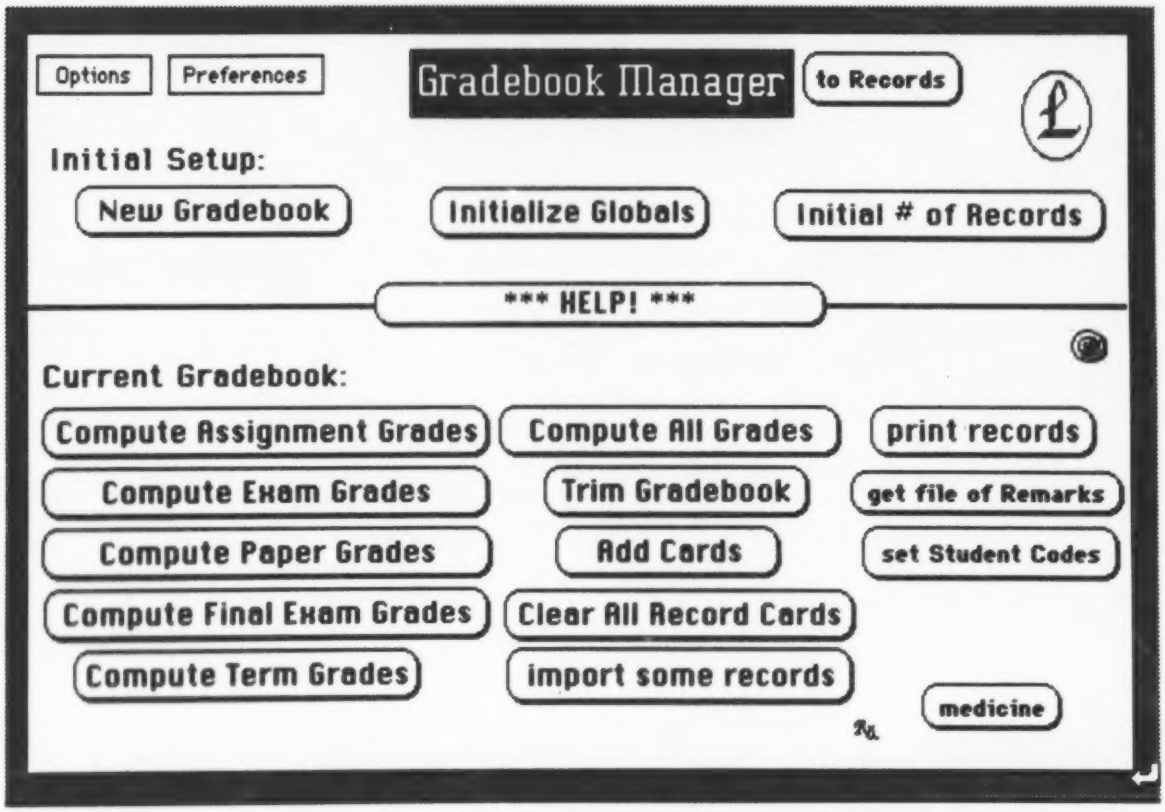

Options
Preferences
Gradebook Manager
to Records
Initial Setup:
New Gradebook
Initialize Globals
Initial # of Records
*** HELP! ***
Current Gradebook:
Compute Assignment Grades
Compute All Grades
print records
Compute Exam Grades
Trim Gradebook
get file of Remarks
Compute Paper Grades
Add Cards
set Student Codes
Compute Final Exam Grades
Clear All Record Cards
Compute Term Grades
import some records
medicine

Figure 2. A Screen from a Macintosh gradebook program.

- *SkyGlobe.* This computer simulation of a planetarium will recreate on your computer screen a high resolution view of the night sky from any location on the earth. It is a DOS program in the subject/science subdirectory.
- *Aspects* educational demonstration program. A demonstration version of conferencing software from Group Logic that is used in many English composition courses to support shared editing of student writing.
- *LinkWay Archive* files. MarkWhitman collects LinkWay files created by teachers and students all over the world and makes them available through the International Public Domain K-12 LinkWay Archive. All the files in that archive, as of November, 1993, are on the CD. For example, one program developed by Jorivoj Brdicke from the Czech Republic is about Prague.
- *Mastering Calculus* demo. A demonstration of a computer assisted instruction package for calculus from the Nectar Foundation in Canada.
- *Health Security Act.* This file is an electronic version of the entire bill submitted to Congress by President Clinton. It is in the form of an electronic book that can be search electronically using keywords and boolean logic. It was supplied by Folio Corporation to demonstrate their software, Folio.

In Summary

The CD-ROM produced at the University of Houston will be distributed nationally. It contains over a thousand programs, documents, fonts, graphics, photographs, and video clips a teacher educator can use in a variety of ways. A few possibilities include:

- The CD has different types of software that can be used as examples in lecture/demonstrations.
- You can provide students in methods and educaional computing courses with a convenient source of programs for evaluation.
- In courses where students are required to do microteaching, the CD is a convenient sourse of software that can be used in sample or demonstration lessons.
- *Browsing* the CD gives you an idea of the types of programs available today. The demonstration versions of commercial applications programs, and educational software, can be used to make individual and group decisions about what software to purchase.
- The graphics, sounds, fonts, and video clips can be used in teacher- and student-developed materials such as posters, overheads, and hypermedia programs.
- Finally, since many of the files are public domain, they can be used in classrooms with students at no cost. For example, the photographs of space missions provided by NASA could be used in a science class by students creating multimedia reports on space travel.

We called this CD *The First Teacher Education CD-ROM* but it certainly should not be the last. The capacity and economy of CD-ROMs make them an ideal distribution medium for large collections of software. We hope others will develop and make available a whole range of CDs with titles like "The Science Teacher Education CD," "The Social Studies CD," and "The Constructivist's Resource CD."

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